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The Predictive Ability and Profitability of Technical Trading Rules: Evidence from the Asia-Pacific Stock Markets

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A thesis
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Abstract of a thesis submitted in partial fulfilment of the requirements for the Degree of M.C.M.

The Predictive Ability and Profitability of Technical Trading Rules: Evidence from the Asia-Pacific Stock Markets

By Hao Yu

This study investigates whether moving average and trading range breakout rules can outperform a simple buy-and-hold strategy to forecast stock price movements and earn excess returns after adjusting for transaction costs in twelve Asia-Pacific stock markets from January 1991 to December 2008.

The empirical results show that the trading rules have stronger predictive power in the emerging stock markets than in the developed stock markets. In addition, the short-term variants of the technical trading rules may be more useful in detecting the predictive ability of the technical trading rules. In examining the profitability of the technical trading rules, the study shows that transaction costs can eliminate the trading profits for most stock markets. The empirical results show that the technical trading rules are profitable in Thailand, Shenzhen, and Korea stock markets after adjusting for transaction costs. There is no evidence of the profitability of the technical trading rules in other stock markets after transaction costs. In order to investigate the relationship between market efficiency and the profitability of the technical trading rules, the study compares the excess returns between six developed stock markets and six emerging stock markets during the test period. The empirical results show that the technical trading rules performed better in the emerging stock markets than in the

developed stock markets. This implies that the developed stock markets are efficient and using the technical trading rules may not be profitable.

Keyword: Technical trading rules; Asia-Pacific stock markets; Efficient market hypothesis (EMH); Transaction costs.

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CHAPTER ONE

INTRODUCTION

1.1. Introduction of technical trading rules

Technical analysis and trading rules are considered as one of the earliest forms of investment analysis because stock prices and volume levels have been publicly available before other types of financial information (Lento, 2007). Technical analysts attempt to predict stock price movements by studying the past price of a time series. Fama (1970) investigated the efficient market hypothesis (EMH), and indicated that share prices are efficiently set and reflect all available information, such that using trading rules based on historical data should not be profitable. However, contrary to this, other research suggested that stock returns are not fully explained by common risk measures, such as price-earnings ratio, market-to-book ratio, and firm size (Brock, Lakonishok, and LeBaron, 1992).

Several researchers investigated the weak-form EMH based on tests of whether different technical trading rules could earn profits. For example, filter rules (Fama and Blume, 1966), relative strength rules (Ackemann and Keller, 1977; Brush and Boles, 1983; Jacobs and Levy, 1988) and moving average trading rules (Van Horne and Parker, 1967; James, Jr., 1968) were all examined. These studies showed that returns earned by using technical trading rules, which are based on exploiting trends in historic share price data, cannot outperform a buy-and-hold strategy, and the predictable variation in equity returns is economically and statistically very small. These studies concluded that by the early 1990s, it is not possible to outperform the market using technical trading rules.

Since the early 1990s, some researchers have found evidence that simple trading rules are useful for predicting stock market returns. Brock et al. (1992) investigated two simple technical trading rules: moving average trading rules (MA) and trading range breakout rule (TRB). The authors showed that the two simple trading rules have significant predictive power for the US equity index returns. They defined the moving average trading rules as rules that are implemented by comparing two moving averages calculated over different time periods, one long-run period and the other short-run period. In addition, buy and sell signals are generated by the two different moving average periods. This strategy is expressed as buying (selling) when the short-period moving average rises above (fall below) the long period moving average. The trading range breakout rule generates a buy (sell) signal as the stock price penetrates new highs (lows) (Brock et al., 1992). These two simple trading rules will be evaluated by their ability to forecast future price changes. Other studies that supported trading rules have the predictive ability include Hudson, Dempsey, and Keasey (1996), Bessembinder and Chan (1995, 1998), Metghalchi and Glasure (2007).

Apart from analysts in the stock markets, technical trading rules are also used by several other financial securities, such as currency and futures markets. For example, Levich and Thomas (1993), Neely and Weller (1999), and Schulmeister (2008), all these studies reported the profitability of technical trading rules used in currency and futures markets.

1.2. Research question

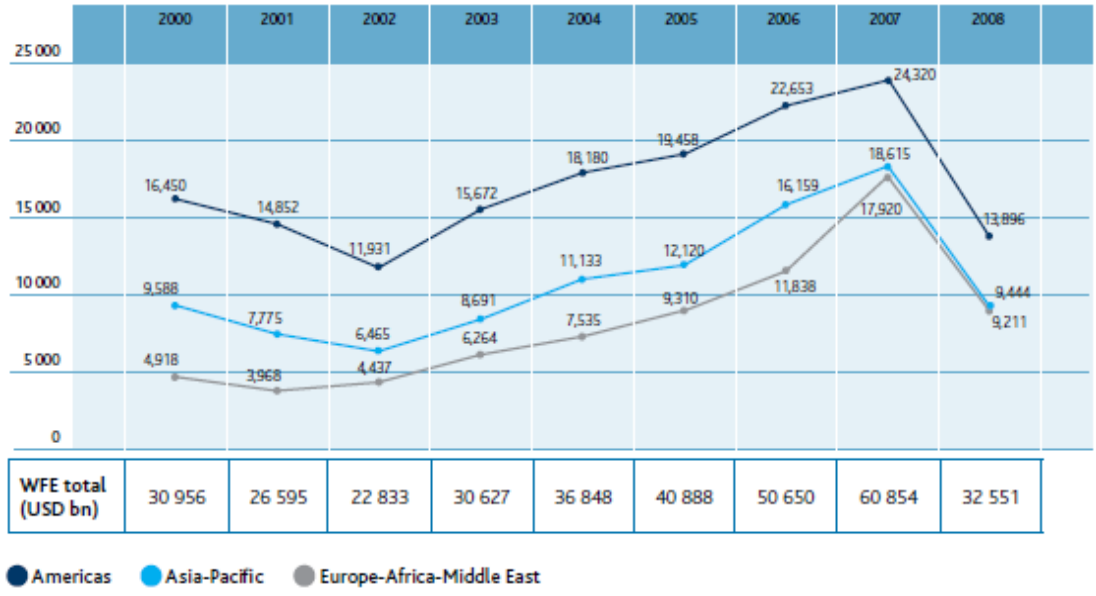
The use of trading rules to predict stock price in the US is probably as old as the stock market itself. More recent studies of both US equity market (Brock et al., 1992) and the currency market (LeBaron, 1999; Schulmeister, 2008) have indicated that some technical trading do indeed have predictive ability to forecast stock price movements. However, the relatively new and emerging stock markets in the Asia-Pacific region have not been examined extensively. If the Asia-Pacific stock markets are in fact relatively inefficient, technical trading rules may be useful to predict stock returns. This study focuses on two simple technical trading rules: moving average (MA) and trading range breakout (TRB) rules. The research question of this study investigates whether the two simple technical trading rules can outperform a simple buy-and-hold strategy to forecast stock price movements and earn excess returns based on certain trading rules in Asia-Pacific stock markets with different efficiency levels. Hence, we examine the predictive ability and profitability of the two simple trading rules using data on twelve stock market indices including Australia, New Zealand, Japan, Hong Kong, South Korea, Singapore, Malaysia, Indonesia, Thailand, Shanghai, Shenzhen, and the Philippines.

1.3. Review of Asia-Pacific stock markets

The major Stock Exchanges in the Asia-Pacific stock markets includes Tokyo, Osaka, Shanghai, Shenzhen, Hong Kong, Bombay, Australian, New Zealand, National Stock Exchange of India, South Korea, Taiwan, Singapore, Malaysia, Indonesia, Thailand, and the Philippines Stock Exchanges. Recently, the Asia-Pacific stock markets have attracted interests from investors and academicians due in part to the rapid growth in Asia-Pacific market capitalization. For example, the Asia-pacific region accounted for

23% of the total market capitalization of the Financial Times Actuaries World Index in 1980 and reached 35% at the end of 1990 (Bessembinder and Chan, 1995). Figure 1.1 shows the growth of market capitalization in the Asia-Pacific region. In spite of the reduction on the market capitalizations for Americas, Asia-Pacific, and the Europe-Africa-Middle East stock markets due to the global financial crisis in 2008, the region still demonstrates rapid growth. Thus, global investors cannot afford to abandon the Asia-Pacific stock markets totally.

Figure 1.1: Recent evolution of domestic market capitalization by time zone in USD billion



Source: World Federation of Exchanges (WFE), at December 31, 2008.

The stock markets in the Asia-Pacific region have different levels of development. Our study uses observations on stock price indices for the more developed stock markets of Australia, New Zealand, Japan, Hong Kong, South Korea, and Singapore; and the emerging stock markets of Malaysia, Indonesia, Thailand, China (Shanghai A- and Shenzhen A-Index), and the Philippines. China is the latest country to

establish two official stock exchanges: the Shanghai Exchange in December 1990 and the Shenzhen Exchange in July 1991. The Chinese stock markets have attracted much attention because of the country's rapid economic growth and the demand of foreign investors to participate in the markets. China stock markets trade two main classes of stocks. This included the A shares (denominated in local currency, RMB or CNY) which are only available to Chinese nationals, and the B shares (listed on the Shanghai Stock Exchange and traded in the U.S. dollars and listed on the Shenzhen Stock Exchange and traded in the Hong Kong dollars) which are available to both nationals and foreign investors. The A-share stock market is much larger than the B-share stock market in terms of the number of listed firms and market capitalization. The number of B-share listed firms is very small compared to A-share listed firms. For example, the numbers of A-share and B-share listed firms on the Shanghai Stock Exchange are 810 and 54, respectively, at the end of year 2008[1]. In addition, the A-share stock market represents more than 97% of total market capitalization. Hence, this study focuses only on the Chinese A-share traded on both Shanghai and Shenzhen Stock Exchanges.

Many Asian markets are dominated by a few large companies with ownership concentrated in the hands of a small number of investors, and insider trading behaviour is prominent. In addition, the requirements for financial disclosures are less regulated, leading to a scarcity of publicly available information (Bessembinder and Chan, 1995). Risso (2008) also supported the hypothesis that emerging stock markets are more inefficient than the developed markets. If share prices are efficiently priced and reflect all available information, using trading rules based on historical data do

[1] Source retrieved from National Bureau of Statistics of China at http://www.stats.gov.cn.

not earn abnormal returns (Fama, 1970). This implies that if the Asia-Pacific stock markets are in fact relatively inefficient, then technical trading rules may be able to exploit the inefficiencies.

1.4. Significance of the research topic

There are several reasons why applying the two simple technical trading rules (MA and TRB) to the twelve Asia-Pacific stock markets offer a valuable contribution to the current literature. First, many finance theories, supported by empirical work in developed stock markets (such as Fama and Blume, 1966; Ackemann and Keller, 1977; Brock et al., 1992; Hudson et al., 1996) have not thoroughly examined in the relatively new and emerging Asia-Pacific stock markets. Most of the above previous studies are based on the US and the UK stock markets. There are limited number of studies implementing both MA and TRB rules in the Asia-Pacific stock markets region, especially in the Australian and New Zealand stock markets. The results will be interesting for the two stock markets as there has been little research undertaken in the Australia and New Zealand equity markets. Therefore, not a great deal is known about the efficiency and share price predictive ability in the two stock markets.

Unlike the large US and UK stock markets, some of the Asia-Pacific stock markets are relatively small. Figure 1.1 shows that the market capitalization of the Asia-Pacific region is small compared to its US and Europe counterparts. In this study, both the New Zealand Stock Exchange (NZSE) and the average firm size are considered very small when compared to overseas stock markets such as the Australian and Chinese stock markets. For example, in 2007, the market capitalization of NZSE is $US 47.5 billion, $US 1298.3 billion for the Australian Stock Exchange,

and $US 4478.8 billion for the Chinese Stock Exchange (total of both SHSE and SZSE)[2]. Therefore, this study examines the effectiveness of Brock et al.'s (1992) technical trading rules in the relatively small Asia-Pacific stock markets with different levels of development.

Second, the results of this study will either support or oppose EMH: if the technical trading rules based on exploiting historical share price data have predictive ability and are profitable, this is taken as evidence against EMH; while if these rules do not have predictive ability and are not profitable then this is considered as evidence in support of EMH. Overall, the results are important because they provide investors with information about the Asia-Pacific stock markets that can be used to determine optimal asset allocations and to further diversify their portfolios. An investor chooses how to allocate his wealth optimally between a riskless stock and a risky one. If technical trading rules can predict stock price movements, investors can effectively use this technical analysis to determine optimal asset allocations. For example, if the investor invests an optimal fixed proportion of his money into the stock market, say 80%, when there is no technical signal generated, he/she should invest more than 80% when a buy signal emitted by technical trading rules and less otherwise.

Third, this study differs from other studies in several ways: firstly, this study provides a more comprehensive examination of technical trading rules on Asia-Pacific stock markets. This study uses more recent data to examine 60 technical trading rules (both MA and TRB) in twelve Asia-Pacific stock markets. As discussed before, some previous studies have focused on the Asian stock markets (Bessembinder and Chan,

[2] Available from **http://www.business.nsw.gov.au**

1995, Cai, Cai, and Keasey, 2005), but little research tested the Asia-Pacific region (including Australia and New Zealand stock markets). This study covers twelve stock markets and compares the effectiveness of technical trading rules in this region. Secondly, we use daily inflation adjusted returns instead of nominal returns to compute trading returns. This is important since high level of inflation is present in many of the emerging Asia-Pacific stock markets. All above studies used nominal returns to calculate technical trading returns. Ratner and Leal (1999) implemented variable-length moving average trading rules (VMA) in ten emerging stock markets of Latin America and Asia (India, Korea, Malaysia, Taiwan, Thailand, and the Philippines) and use daily inflation adjusted returns to calculate technical trading returns. Our study examines more technical trading rules (VMA, FMA, and TRB trading rules) in twelve Asia-Pacific stock markets and inflation is factored in computing the trading returns. In addition, we compare the difference for the technical trading returns when inflation is taken into account and not. Thirdly, this study does not only test the technical trading rules with a 1% band, but also compare the difference when implementing trading rules with bands of 0%, 0.5%, 1%, and 3%.

In general, this study contributes to the overall understanding of the efficiency and pricing behaviour of the Asia-Pacific stock markets. This is important since the Asia-Pacific stock markets are developing into a very significant participant in the global stock market.

1.5. Research objectives and hypotheses

We examine the excess returns in twelve Asia-Pacific stock markets during the period 1991-2008, and compare the excess returns between these markets with different

efficiency levels. This study uses the same framework proposed by Brock et al. (1992) and Bessembinder and Chan (1995, 1998). The research objectives include:

1) To examine whether the technical trading rules can predict stock price movements.

2) To test whether using technical trading rules can generate excess returns after considering for transaction costs.

3) To investigate the relationship between market efficiency and the profitability of technical trading rules.

Three hypotheses are tested. The first hypothesis tests the predictive ability of technical trading rules. To examine the predictive ability of technical trading rules, we use the same process proposed by Brock et al. (1992). They indicated that technical trading rules have predictive ability when buy signals generate positive returns and sell signals generate negative returns which are, on average, significantly different from the returns earned by a simple buy-and-hold strategy. In our tests, if the buy signals earn positive returns and sell signals earn negative returns, and the mean daily buy and sell returns are not equal to returns generated by a simple buy-and-hold strategy, we can then conclude that the technical trading rules have predictive ability. Hypothesis 1 is proposed as follows:

Hypothesis 1: Buy signals earn positive returns and sell signals earn negative returns, and the mean daily buy and sell returns generated by the technical trading rules are significantly different from the returns earned by a buy-and-hold strategy.

The second hypothesis tests the profitability of technical trading rules. In this study, we follow the same procedure proposed by Bessembinder and Chan (1995, 1998).

The profitability of the trading rules is determined by comparing the returns earned by the trading rules to the returns earned by a buy-and-hold strategy. In addition, transaction costs are considered. In this study, we estimated the breakeven costs that are needed to offset the additional returns generated by the technical trading rules relative to the simple buy-and-hold strategy. Then the estimated breakeven costs are compared to the estimated actual transaction cost, to examine the profitability of technical trading rules. If the breakeven costs are greater than the estimated actual transaction costs, we can conclude that the technical trading rules have profitability. Hypothesis 2 is proposed as follows:

Hypothesis 2: The estimated breakeven cost for each technical trading rule is greater than the estimated actual transaction cost.

Previous researches showed that the technical trading rules perform better in the emerging stock markets than in the developed stock markets (Bessembinder and Chan, 1995; Tian, Wan, and Guo, 2002). This study attempts to determine the relationship between market efficiency and profitability of technical trading rules. Hence, the third hypothesis is tested. Hypothesis 3 is proposed as follows:

Hypothesis 3: Technical trading rules are more profitable in the emerging stock markets than in the developed stock markets.

1.6. Outline of thesis

This thesis consists of five chapters. Chapter One provides the overall background information, research problem, research objectives and hypotheses. Chapter Two reviews significant prior research in technical trading rules in both developed and emerging stock markets. Chapter Three describes the data and research methodology

used in the study. Chapter Four discusses the empirical findings and results. Chapter Five outlines the results implications, research limitations, recommendation for future studies, and conclusions of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter reviews the studies relevant to the predictive ability and profitability of technical trading rules. Section 2.2 reviews the earlier studies in technical trading rules. Section 2.3 reviews the empirical studies in technical trading rules in the developed stock markets. Section 2.4 reviews the recent studies of the technical trading rules investigated in Asian stock markets. Section 2.5 reviews the relevant studies on the relationship between market efficiency and profitability of technical trading rules. Section 2.6 reviews the empirical studies of technical trading rules in other financial securities markets, and Section 2.7 concludes the chapter.

2.2. Early studies of technical trading rules

Fama (1970) defined an efficient financial market as one in which stock prices always fully reflect the available information. Any new information will be quickly and instantaneously reflected in the security prices. Moreover, since news on any company arrives randomly, price changes are also unpredictable or follow a random walk. Fama (1970) investigated the EMH and classified the EMH into three categories: (a) weak-form, (b) semi-strong-form, and (c) strong-form market efficiency, according to the level of information investigated. The weak-form EMH implies that future prices cannot be predicted by analysing share prices from the past. This means that investors cannot earn profits greater than that derived from a buy-and-hold strategy when using any technical trading rule that depended solely on historical share price data. Therefore, if the market is weak-form efficient, technical analysis based on investigating historical prices are useless.

Early empirical studies on the EMH test whether different trading rules could earn profits, such as filter rules (Alexander, 1961, 1964; Fama and Blume, 1966; Sweeney, 1988), relative strength rules (Levy, 1967a, 1967b; Jenson and Benington, 1970; Brush and Boles, 1983; Jacobs and Levy, 1988), and moving average trading rules (Van Horne and Parker, 1967; James, Jr., 1968; Dale and Workman, 1980). The filter rule first introduced by Alexander (1961) is the most popular rule tested by many researchers. According to the filter technical rule, a trader buys stocks if the share price rises by a fixed percentage (say 5%-50%) and sells stocks if the share price falls by the same percentage. Alexander (1961) tested a number of filter rules on the Dow Jones and Standard & Poor's stock indices over the periods 1897-1959, and concluded that these technical rules yielded returns above the simple buy-and-hold strategy. In addition, Alexander is the first to examine the profitability of technical trading rules on individual US stocks. Alexander (1964) found that the profitability of filter rules disappeared with the inclusion of transaction costs. Alexander's conclusions are supported by Fama and Blume (1966).

Fama and Blume (1966) examined the profitability of various filter trading rules based on daily data of 30 individual securities on the Dow Jones Industrial Average (DJIA) during the period 1956-1962 and compared technical trading returns to the returns generated by a buy-and-hold strategy. Their results revealed that across all 30 securities, there are only three out of twenty-four filter trading rules that generated higher returns than the returns earned by a simple buy-and-hold strategy. They rejected the hypothesis that there is important information in past prices that could earn excess returns in excess of a simple buy-and-hold strategy.

Levy (1967a, 1967b) tested a number of relative strength rules using weekly closing share prices on 200 securities listed in the New York Stock Exchange from October 1960 to October 1965. The relative strength rule relates a security's current prices to its average prices over a specified period, and ranks this ratio for all the securities under consideration from high to low. Stocks that rank a high score on the relative strength measure are considered as a good investment (Levy, 1967a, 1967b). Levy (1967a, 1967b) concluded that some variations of the relative strength trading rules performed significantly better than a simple buy-and-hold strategy. However, Jensen (1967) identified several errors in Levy's (1967a) results. Jensen (1967) discussed some of the problems involved in evaluating trading rules proposed by Levy (1967a). Levy's (1967a) results overstated the excess returns generated by the trading rules relative to the returns generated by the buy-and-hold strategy. Levy (1968) constructed an additional test on one of the relative strength trading rules using the daily closing prices of 625 securities listed on the New York Stock Exchange from July 1, 1962 to November 25, 1966. Levy (1968) reported that the trading rule yield returns of 31% per annum and argued that stock prices follow discernible trends where using technical trading rules could yield higher returns, rejecting the theory of random walk. Jenson and Benington (1970) examined two of Levy's (1967a) relative strength trading rules using a sample of 200 securities listed on the New York Stock Exchange from 1960-1965. They found that the technical trading rules could not earn returns significantly more than the buy-and-hold strategy for the US equity market when transaction costs are considered.

Van Horne and Parker (1967) examined the moving average trading rules using 30 industrial stocks from the New York Stock Exchange. They used daily closing prices

adjusted for stock splits and dividends for each individual stock for the period January 1, 1960 to June 30, 1966. They examined the moving average trading rules, which means that investors buy (sell) a security if its current share price rises above (falls below) its average price over the previous 100, 150, 200 days by a certain percentage. Their results reported that none of the 30 industrial stocks proved profitable when compared with a simple buy-and-hold strategy. James, Jr. (1968) in his study obtained similar conclusions. James, Jr. (1968) investigated moving average trading rules using monthly share price data for the period 1926-1960. The author examined the predictive power of moving average trading rules, which enables investors to sell their securities near the peak price and repurchase near the bottom of the declining price. James, Jr. (1968) revealed that using a monthly moving average rules did not predict the future price movements and offer investors a significant profit.

Other studies have long supported the weak-form EMH (see Roberts, 1959; Mandelbrot, 1963; Fama, 1965). These studies showed that exploiting trends in historical share price data do not yield returns superior to a buy-and-hold strategy even before transaction costs are taken into consideration. By the early 1990s, the conclusion is that it is not possible to outperform the market using technical trading rules (Metghalchi and Glasure, 2007). However, from the early 1990s, several researches presented evidence that some simple trading rules are useful for predicting stock market returns. The predictive ability and profitability of the technical trading rules has been studied in both developed and emerging stock markets.

2.3. Previous studies on the technical trading rules in developed stock markets

2.3.1. Predictive ability and profitability of technical trading rules

Recent studies showed that some technical trading rules do have the ability to forecast price movements in the developed stock markets. Two studies provided important evidence on the predictive ability and profitability of technical trading rules in two major developed stock markets with long series price histories. Brock et al. (1992) analyzed the data on the Dow Jones Industrial Average (DJIA) for a 90-year period from 1897 to 1986; Hudson et al. (1996) replicated Brock et al.'s (1992) test and examined prices for the Financial Times Industrial Ordinary Index (FTI) in the UK over a period of 59 years from 1935 to 1994. Both studies tested two simple technical trading rules: moving average (MA) and trading range breakout (TRB) trading rules.

The general conclusion is that these technical trading rules have predictive ability if a long price series data is used. Buy signals offer a positive return whereas sell signals offer a negative return; buy signals generate higher returns than sell signals. When the variable length moving average rule (VMA) is used, Brock et al. (1992) found that the VMA rule earned an average 1-day return of 0.042% on buy strategies and -0.025% on sell strategies. When fixed length moving average rule (FMA) is used, they found that the FMA rule earned an average 10-day return of 0.53% on buy strategies and -0.40% return on sell strategies. The average 10-day return based on trading range breakout rule is slightly higher at 0.63% for buy strategies and -0.24% for sell strategies. Similarly, Hudson et al. (1996) concluded in the UK stock market that the average 1-day return based on VMA rule is 0.058% on buy strategies and -0.021% on sell strategies, the average 10-day holding period return for buy strategies based on FMA rule is 0.99% and for sell strategies is -0.63%. The TRB rule generated an average 10-day return of 0.70% for the buy strategies and -0.43% for the sell strategies.

Brock et al.'s (1992) results provided strong empirical evidence that technical trading rules have predictive power and could earn higher returns compared to the unconditional returns (buy-and-hold returns). However, they did not examine whether the trading rules can earn excess returns in a costly trading environment for investors. This costly trading aspect is considered in Hudson et al.'s (1996) investigations of the UK stock market. The authors hypothesized that the ability of technical trading rules to earn excess returns directly depends on the profits generated per round trip transaction. Furthermore, Bessembinder and Chan (1998) investigated Brock et al.'s (1992) study adjusting for transaction costs and non-synchronous trading for the US equity market from 1926 to 1991. Their results confirmed Brock et al.'s (1992) results and concluded that the simple forms of technical trading rules contain significant predictive power for the US equity index returns. After adjustments for transaction costs and non-synchronous trading, Bessembinder and Chan (1998) found that the technical trading rules profits are eliminated in the US equity market.

The above studies demonstrated that the technical trading rules have predictive ability. The evidence to support the predictive ability of technical trading rules is also found in Gencay and Stengos (1997, 1998), Gencay (1998a, 1998b, 1999), LeBaron (1999), Ratner and Leal (1999), and Fernandez-Rodriguez, Gonza´lez-Martel, and Sosvilla-Rivero (2000) studies. However, the predictive ability of the technical trading rules may not necessarily imply profitability. According to Hudson et al. (1996) for the UK stock market and Bessembinder and Chan (1998) for the US stock market, their studies indicated that transaction costs eliminate trading profits. When transaction costs are included in the analysis, the authors found that the use of technical trading rules would not allow investors to make excess returns over a simple

buy-and-hold strategy. Thus, it is important to account for transaction costs. Other researchers also did not support the profitability of technical trading rules in the US equity market. For example, Szakmary, Davidson, and Schwarz (1999) examined the performance of filter and dual moving average crossover trading rules on the NASDAQ stocks from January 1, 1973 to December 31, 1991. The authors found that the technical trading rules for individual stocks performed poorly, but trading rules for the overall NASDAQ index earned statistically significant abnormal returns. The authors believed that these abnormal returns are generally not economically significant for investors because of a high level of transaction costs associated with NASDAQ trading. Tian et al. (2002) explored the predictive ability and profitability of technical trading rules in the US and Chinese equity markets. In the case of the US equity market, they reported that both MA and TRB trading rules have no predictive ability after 1975. Allan and Karjalainen (1999) used daily price data to examine moving average trading rules during the period 1928 to 1995. They also obtained similar conclusions, and concluded that trading rules do not earn consistent excess returns over a simple buy-and-hold strategy when adjusted for transaction cost in the out-of-sample test periods. Ready (1998) examined Brock et al.'s (1992) technical trading rules using data from NYSE during the periods 1988-1992. Ready tested the technical trading rules that account for transaction costs and potential price slippage based on more recent data. These trading rules are unprofitable and could not beat the buy-and-hold strategy.

However, some researchers found evidence to support the profitability of technical trading rules even in the US equity market with the inclusion of transaction costs. Pruitt and White (1998) used CRSP daily price data over the period 1976-1985, and

concluded that the technical trading rules are capable of outperforming a simple buy-and-hold strategy with transaction costs. Kwon and Kish (2002) applied three popular technical trading rules (moving average of prices, moving average of prices with momentum, and moving averages of both prices and trading volume) to the NYSE value-weighted index over the period 1962-1996, and concluded that the technical trading rules have the potential to capture profit opportunities over various models when compared to buy-and-hold strategies. The methodologies they employed include the traditional t-test and residual bootstrap methodology that included random walk, GARCH-M and GARCH-M with some instrument variables. In the sub-samples test, their results are weaker in the last sub-period, 1985-1996. This implied that the US market is getting informationally efficient over the recent years due to technological improvements. Lento and Gradojevic (2007) investigated the profitability of several technical trading rules (filter rule, moving average cross-over rule, Bollinger Bands, and trading range break-out rules) on the Toronto Stock Exchange (TSX), the DJIA Index, the NASDAQ Composite Index, and the Canada/US spot exchange rate for the period May 1995 to December 2004. After accounting for transaction costs, both the moving average cross-over and trading range breakout rules are profitable for the TSX, NASDAQ and the Canada/US spot exchange rate. Filter rules also generated excess returns when applied on the Canada/US spot exchange rate. However, the technical trading rules could not beat the buy-and-hold strategy to earn excess returns for the DJIA Index. Similarly, Bollinger Bands trading rules performed poorly for the TSX, NASDAQ, and DJIA indices.

Other studies also found evidence to support the predictive ability and profitability of the technical trading rules outside the US stock market. For example, Metghalchi and Chang (2003) examined two different moving average rules (VMA and FMA) and discovered that the moving average trading rules beat the buy-and-hold strategy for the Italian stock market. Metghalchi and Glasure (2007) tested the TRB rules for the Greek stock market for the period January 2, 1990 to May 24, 2006, and noted that the TRB rules do indeed have predictive power and supported the hypothesis that technical trading rules can generate higher pre-transaction costs returns than the buy-and-hold strategy. Metghalchi, Glasure, Garza-Gomez, and Chen (2007) tested two moving average technical trading rules for the Austrian stock market for the period January 2, 1990 to May 17, 2006. Their results confirmed that the technical trading rules could outperform the buy-and-hold strategy. Metghalchi et al. (2007) concluded that moving average rules have the predictive ability and the break-even one way trading costs are estimated to be between 0.61% and 2.36%, which are greater than the recent estimates of actual trading costs. This implied the presence of profitability of technical trading rules in the Austrian stock market.

Mills (1997) examined two types of technical trading rules, the moving average and trading range breakout rules in the London stock market using daily data on the FT30 Index over the period 1935-1994. The author's results are similar to Hudson et al. (1996). After assessing the statistical significance of the rules by AR-ARCH models and bootstrap methodology, Mills (1997) found that the technical trading rules could predict stock price movements and produced a return greater than a buy-and-hold strategy only in periods when the market is inefficient, at least up to the early 1980s. Since then, the trading rules did not beat the buy-and-hold strategy.

Chong and Ng (2008) examined two technical trading rules (Moving Average Convergence–Divergence (MACD) and the Relative Strength Index (RSI)) to test if these rules are profitable. They used the London Stock Exchange FT30 Index of Mills (1997) from July 1935 to January 1994. They found that the RSI as well as the MACD rules could generate returns higher than the buy-and-hold strategy in most cases. However, Chong and Ng (2008) did not adjust for transaction costs in their study. Hudson et al. (1996) indicated that trading profits depend on the magnitude of transaction costs in the UK equity market. Bokhari, Cai, Hudson, and Keasey (2005) replicated Brock et al. (1992) and Hudson et al.'s (1996) studies to investigate the predictive ability and profitability of simple technical trading rules (MA and TRB) for different company sizes. Their study tested the technical trading rules for a sample of 100 UK stocks for the period January 1, 1987 to July 22, 2002. Their results suggested that the technical trading rules have higher predictive ability the smaller the size of the company, but are not profitable after accounting for transaction costs. In addition, Isakov and Hollostein (1999) found that transaction costs eliminate trading rules profits in the Swiss equity market.

Vasiliou, Eriotis, and Papathanasiou (2008) investigated the profitability of the moving average trading rules using daily price data for the period 1995 to 2005 in the Athens Stock Exchange (ASE). They followed similar methodology with Brock et al. (1992) but adding transaction costs. Their results provided strong support for the predictive ability and profitability of moving average technical trading rules. All the buy-sell differences are positive and the t-tests for these differences are highly significant rejecting the null hypothesis of equality with zero. The mean buy returns have an average daily return of 0.085% which is 21.25% annually. The t-statistics

rejected the null hypothesis that the returns equal the buy-and-hold returns (0.0521% or 13% annually). These results indicated that these technical trading rules have predictive ability. Overall, their technical strategies beat the market. In particular, the buy-and-hold strategy earned 13% per year profit and using moving averages strategy earned 29.25% per year profit. The results provided strong support for the profitability for the examined technical trading rules.

Furthermore, there is evidence that the effectiveness of the technical trading rules may differ between companies with different sizes. Blume, Easley, and O'Hara (1994) established profitable technical analysis with trading volumes. They developed a new equilibrium model where investors learn from both the past prices and volume. The authors found that traders who used information contained in market statistics do better than traders who do not. They concluded that technical analysis maybe more appropriate for the small stocks rather than large stocks. Chandrashekar (2005) investigated moving average trading rules using the daily index series of the ten CRSP (NYSE, AMEX and NASDAQ) size deciles index data from July 1963 to December 2002. The author found that the technical trading returns declined sharply in size. Chandrashekar's (2005) results supported Blume et al.'s (1994) hypothesis that technical analysis maybe more appropriate for small stocks. Lo and MacKinlay (1988), Lo and MacKinlay (1990), Knez and Ready (1996), and Conrad and Kaul (1998) also confirmed that trading strategies are more useful for small-firm stocks.

In general, for most of the developed stock markets, such as the US and UK equity markets, the technical trading rules have predictive ability, but the technical trading profit are eliminated after adjusting for transaction costs. However, evidence of the

predictive ability and profitability is also found in the more volatile emerging stock markets.

2.4. Previous studies on the technical trading rules in Asia-Pacific stock markets

2.4.1. Predictive ability and profitability of technical trading rules

The Asia-Pacific stock markets are developing into a very significant participant in the global stock markets, and recent research has analyzed the effectiveness of the simple technical trading rules due to the rapid growth in the Asia-Pacific markets. The empirical studies indicated that the simple technical trading rules have predictive ability when implementing them in different countries. Bessembinder and Chan (1995) provided important evidence to support the usefulness of the technical trading rules. They are amongst the first to show that the moving average and trading range breakout technical trading rules have the predictive ability to forecast stock price movements for a group of Asian stock markets. Bessembinder and Chan (1995) examined both MA and TRB rules evaluated by Brock et al. (1992) using stock price indices from Japan, Hong Kong, South Korea, Malaysia, Thailand, and Taiwan for the period January 1975 to December 1989. In general, they found that Brock et al.'s technical trading rules are successful in predicting stock price movements in the emerging stock markets of Malaysia, Thailand, and Taiwan; but have less explanatory power in the more developed stock markets of Hong Kong and Japan. To evaluate the profitability, the authors used a "double or out" strategy. Under this strategy, an investor borrows to double the investment when the technical trading rules generate buy signals and sell stocks to invest at risk-free interest rate when the technical trading rules generate sell signals. The authors estimated the breakeven transaction costs which are required the offset the additional returns generated by the technical

trading rules relative to a simple buy-and-hold strategy. The estimated breakeven transaction costs are compared with the actual current trading costs. Following the adjustment of non-synchronous trading and transaction costs, their results showed that the estimated breakeven transaction costs are greater than the actual transaction costs for the stock markets of Malaysia, Thailand, and Taiwan. This implies that the technical trading rules are profitable in these three stock markets. For the more developed stock market of Hong Kong and Japan, the technical trading rules are not profitable.

Ratner and Leal (1999) examined the profitability of ten VMA technical trading rules in ten Latin America and Asia emerging equity markets of India, Korea, Malaysia, Philippines, Taiwan, Thailand, Argentina, Brazil, Chile, and Mexico over the period 1982-1995. Due to the high level of inflation experienced by many emerging markets, daily inflation adjusted returns are computed. The authors compared the average buy returns generated by the technical trading rules less the average sell returns to a buy-and-hold strategy. Their results confirmed the evidence of the profitability in most markets with transaction costs but most of it is concentrated in Taiwan, Thailand, and Mexico. Other equity markets do not show strong support for these technical trading rules.

Ahmed, Beck, and Goldreyer (2000) examined the use of technical analysis to predict stock returns in three volatile and declining Asian stock markets during the period 1994-1999, notably Taiwan, Thailand, and the Philippine. They used ten variable length moving average trading rules (VMA) compared to a simple buy and hold strategy. Ahmed et al.'s (2000) results supported the effectiveness of the technical

trading rules, which implies the presence of strong serial correlation among stock returns that showed predictive ability in future stock returns. Their study agreed with prior studies where the technical trading rules can outperform a simple buy and hold strategy to earn excess returns for investors. Ahmed et al. (2000) documented that emerging stock markets have predictive ability in their market returns generating significant positive profits even with the inclusion of transaction costs. In contrast to the developed stock markets, emerging stock markets exhibit weak-form market efficiency.

Gunasekarage and Power (2001) analysed the performance of moving average trading rules using a period of 10 years during 1990 to 2000 in four emerging South Asian capital markets (Bangladesh, India, Pakistan, and Sri Lanka). "Double or out" strategy is used to examine the profitability of the technical trading rules. Their findings showed that the technical trading rules have predictive ability in the markets, and reject the null hypothesis that returns earned from moving average trading rules are equal to those achieved from the buy-and-hold strategy. In addition, ignoring transaction costs, they also concluded that employing the technical trading rules could generate excess returns relative to a naïve buy-and-hold strategy for investors in the four emerging South Asian stock markets.

Parisi and Vasquez (2000) tested two of the simplest and most popular trading rules (MA and TRB rules) in the emerging Chilean stock market for the period January 2, 1987 to September 9, 1998. Their results were similar to Brock et al.'s (1992) findings. It provided strong support for the predictive ability of technical strategy. Buy signals generated higher returns than sell signals; returns followed by buy signals

are positive and returns followed by sell signals are negative. However, the transaction costs in the Chilean capital market are high, which offset the technical trading returns.

Lai, Balachandher, and Nor (2002) examined the predictive ability of technical trading rules (VMA and FMA rules) using daily returns of the Kuala Lumpur Stock Exchange (KLSE) Composite Index for the period January 1977 to December 1999. They showed that the variance ratio and multiple variance ratio tests reject the random walk hypothesis for the KLSE. In the examination of the technical trading rules, their results were similar to Bessembinder and Chan (1995), indicating that both the VMA and FMA trading rules have predictive ability for the Malaysian Stock Exchange. But Lai et al. (2002) argued that returns generated by the technical trading rules are significantly higher than the unconditional mean return of the buy-and-hold strategy even with transaction costs.

Similarly, Poshakwale (1996), Madhusoodanan (1998), and Pant and Bishnoi (2001) showed that the Indian stock market does not follow a random walk. Achuthan and Anubhai (2005) examined the effectiveness of variable length moving average (VMA) trading rules in the Indian Stock Markets (BSE Sensex) from February 1, 1991 to March 5, 2003. They found that the VMA trading rules do have predictive ability for the Indian equity market. However, this predictive ability is not supported when using the VMA trading rules with larger long-period moving average, such as a 200-day moving average. An individual investor would pay approximately 1% one-way transaction cost. Based on the analysis of post-transaction costs returns, Achuthan and

Anubhai (2005) found that using long variant of the VMA trading rules (such as short period is 5 days and long period is 200 days) fail to beat the buy-and-hold strategy.

The Chinese stock market is one of the biggest emerging stock markets in the Asia-Pacific region. It has attracted much attention because of the country's rapid economic growth and the desire of foreign investors to get involved in the country's growth opportunities (Balsara, Chen, and Zheng, 2007). Darrat and Zhong (2000) examined the random walk hypothesis for Shanghai and Shenzhen stock exchanges in China. They used the variance ratio test and comparison NAÏVE model (based on assumption of random walk) with other models (ARIMA, GARCH, and Artificial Neural Network-ANN). Overall, they rejected the random walk model in the two Chinese stock exchanges. Balsara et al. (2007) also conducted an examination of the random walk model and technical trading rules for A-Shares and B-Shares traded on the Shanghai and Shenzhen stock exchanges respectively from 1990 to 2005. They also rejected the random walk hypothesis for both stock markets. In examining the technical trading rules, they observed significantly positive returns on buy trades generated by the moving average crossover rule, the channel breakout rule, and the Bollinger band trading rule, after adjusting for transaction costs. Their results suggested that the technical trading rules are useful in the Chinese stock markets. However, researchers found that the technical trading rules have different predictive ability and profitability in the two Chinese stock markets (A-Share and B-Share). Wang and Li (2004) examined the performance of the technical trading rules in the Chinese stock market during the period October 6, 1992 to March 31, 2003, and they reported significant evidence to support the predictive ability and profitability of the technical rules for the China's B-Share but not for the domestic A-Share.

Coutts and Cheung (2000) analyzed the Hang Seng Index in Hong Kong during the period 1985 to 1997, and found that both the MA and TRB rules generated marginal abnormal returns before adjusting for transaction costs, but these disappeared for the MA rules with the inclusion of transaction costs. On the other hand, Lam, Yeung, and Cheung (2007) investigated the simple moving average and trading range breakout rules using a 35-year data series for the Hang Seng Index from 1972 to 2006. In general, their results showed that there is only one trading rule, (1,50,0) rule that has outperformed the market (HSI) after including transaction costs over the 35 year testing period. They also found that the average returns generated by the MA trading rules are higher than the returns in the US stock market evaluated by Brock et al. (1992) and the Hong Kong stock market evaluated by Bessembinder and Chan (1995). Finally, Lam et al. (2007) found that the trading rules perform better before 1986 which suggest that the Hong Kong stock market has become more efficient over time.

In summary, the above studies supported the effectiveness of the technical trading rules. The studies indicated that the technical trading rules have predictive ability and profitability when implemented in the Asia-Pacific stock markets.

2.5. Relationship between market efficiency and profitability of technical trading rules

The profitability of the technical trading rules in the emerging stock markets may be associated with the persistence of returns, or autocorrelation in these markets. Harvey (1995a) found that the autocorrelation in the emerging stock markets is much higher than in the developed stock markets. The high autocorrelation indicates that stock prices do not necessarily follow a random walk in the markets. Harvey (1995b) addressed the predictability in the emerging stock markets. Harvey argued that

emerging stock market returns seem to be predictable when using international and local risk factors. Bessembinder and Chan (1995) and Ratner and Leal (1999) showed that non-trivial first order autocorrelations are found in the emerging stock markets. In addition, the researchers found that the technical trading rules performed better in the emerging stock markets than in the developed stock markets. Bessembinder and Chan (1995) documented that the technical trading rules have strong predictive ability in the emerging stock markets of Malaysia, Thailand, and Taiwan, but have less predictive power in the more developed stock markets of Japan, Hong Kong, and South Korea.

Ito (1999) examined the same technical trading rules evaluated by Brock et al. (1992) for six Pacific-Basin countries from January 1, 1980 to December 31, 1996. First, Ito's (1999) results showed that the technical trading rules have predictive power for the five countries, namely Japan, Canada, Indonesia, Mexico, and Taiwan. In contrast to Brock et al.'s (1992) study, Ito (1999) found that the technical trading rules do not exhibit any significant predictive power for the US index. Second, Ito found that the technical trading rules have stronger predictive power for the emerging stock markets compared with developed stock markets. The average buy-sell difference across all trading rules and three emerging stock markets is 0.2302% per day or 77.8% annually compared to the developed stock markets with significant predictive power of 0.1030% per day or 29.4% annually. Third, in the examination of profitability of the technical trading rules, "double or out" strategy is used. Ito's results showed that the trading rules are profitable relative to a buy-and-hold strategy after adjusting for transaction costs. Marshall, Cahan, and Cahan (2009) investigated the technical trading rules (MA and TRB) for 23 developed stock markets and 26 emerging stock markets over the period January 1, 2001 to December 31, 2007. They also found evidence that the

technical trading rules perform better in the emerging stock markets than in the developed stock markets.

Tian et al. (2002) explored the predictive ability and profitability of the technical trading rules (MA and TRB) in markets with different efficiency levels, for the period January 1926 to December 2000 for the US market and October 1992 to December 2000 for the Chinese markets. To examine the usefulness of the technical trading rules, they expanded the variants of the rules from the 26 examined by Brock et al. (1992) to 412. Tian et al. (2002) followed the same process proposed by Bessembinder and Chan (1998), a "double or out" strategy to examine the profitability of the technical trading rules. In the case of US, it is reported that both MA and TRB trading rules have no predictive ability after 1975, but their results support the technical trading rules having both predictive ability and profitability for the Chinese stock market from 1992 to 2000.

Cai et al. (2005) extended the analysis of Tian et al. (2002) to investigate the profitability of technical trading rules in the following equity markets: US, UK, Hong Kong, Japan and China. They examined two trading rules (VMA and TRB) in the five countries for the period May 21, 1992 to October 31, 2003. The authors investigated the predictive ability of technical trading rules and tested whether those rules could earn profits in a costly trading environment. For the developed markets, Cai et al.'s (2005) results supported the findings of Tian et al. (2002) for the US market, in that the technical trading rules had predictive ability during 1970s, but this predictive ability largely disappeared by 1990s. In the case of China, their findings suggested that the technical trading rules have short term predictive ability and could earn

profits in the Chinese stock market during the 1990s, but this is generally reduced as the decade progressed.

Lento (2007) examined three trading rules (MA, TRB, and filter rules) on eight Asia-Pacific equity markets, namely Australia, India, Indonesia, Korea, Japan, Hong Kong, Singapore, and Taiwan, from January 1987 to November 2005. Lento's (2007) results demonstrated that , on average, superior profits (after trading costs) can be achieved by the technical trading rules over the simple buy-and-hold trading strategy in certain countries, namely India, Hong Kong, Indonesia, Korea, Singapore, and Taiwan. There is no evidence of profitability for the Japanese and Australian stock markets.

In summary, the above studies showed that the technical trading rules have predictive ability and can earn excess returns for investors when applying the trading rules. These studies concluded that the technical trading rules perform better in the emerging stock markets than in the developed stock markets. Investors can earn profits when using the technical trading rules in the emerging stock markets even with transaction costs.

2.6. Empirical studies of technical trading rules in other financial securities markets

Technical trading rules are used widely by analysts in the stock markets. However, today these are used with several other financial securities, such as currency and futures markets. Several studies have found the technical trading rules to be profitable when examined in sample based on daily exchange rates (Levich and Thomas, 1993; Neely and Weller, 1999; LeBaron, 1999; Schulmeister, 2008). Schulmeister (2008)

investigated the profitability of the technical rules in the German mark/US dollar market. These studies showed abnormal returns when using simple moving average and momentum trading rules. Schulmeirster (2008) reported that the profitability of technical currency trading has been declining since the late 1980s for the US currency market. Levich and Thimas (1993) used the same bootstrap methodology employed by Brock et al. (1992) to examine the significance of technical trading rules. They found that technical trading profits are not high in some developed countries.

Financial studies suggested the use of forward rate to predict short run movements in currencies. The forward (futures) rate is considered as an unbiased predictor of future spot rates (Ahmed, Beck, and Goldreyer, 2005). Most currencies of emerging economies do not have active futures or forward markets, therefore, the study of technical trading rules are more important for the currencies of the emerging economies. Ahmed et al. (2005) investigated the efficiency in using moving average technical trading rules with currencies of emerging economies. Their sample consisted of currency spot rates for the following emerging markets, Mexico, Chile, Thailand, South Korea, and the Philippines, for the period January 2, 1990 to November 10, 2000. Ahmed et al.'s (2005) results supported the effectiveness of moving average trading rules, which implied strong serial correlation among currency returns for these emerging markets. The predictive ability of the technical trading rules may allow investors to create hedges in the volatile emerging markets.

2.7. Conclusions

Fama (1970) investigated the efficient market hypothesis (EMH), and indicated that using trading rules based on historical data should not be profitable. Early studies

have shown that exploiting trends in historical share price data did not yield returns superior to a buy-and-hold strategy even before transaction costs are taken into account. By the early 1990s, it is not possible to outperform the market using the technical trading rules.

Since 1990s, several studies have revealed that the technical trading rules based on exploiting past share price data have predictive ability but some of them showed that the technical trading rules could not earn excess returns with the inclusion of transaction costs. Brock et al. (1992) reported the profitability of the technical trading rules when ignoring transaction costs in the US equity market. Bessembinder and Chan (1998) replicated Brock et al.'s (1992) test and reported that trading profits can be eliminated by trading costs. All evidence showed that the technical trading rules could not earn profits after adjusting for transaction costs for the US stock market. In the UK, Hudson et al. (1996) reported that transaction costs can eliminate trading profits. They revealed that trading profits depend on the magnitude of transaction costs. This shows that trading costs play an important role in determining the effectiveness of any technical trading rule.

In contrast, evidence has shown that the technical trading rules perform better in the emerging stock markets than the developed stock markets. Empirical studies showed that most of the major Asian stock markets are inefficient in both individual stocks and stock market indices (Risso, 2008). Researchers also found that the technical trading rules have high predictive power in the emerging stock markets and less in the developed stock markets (Bessembinder and Chan, 1995; Cai et al., 2005). This predictive ability can be put to profitable use in a costly trading environment. In

addition, technical trading rules are mostly used by analysts in the stock markets, but today these are also used for several other financial securities, such as currency and futures markets, for both developed and emerging markets.

The literature discussed in Chapter two focuses on different technical trading rules. There are also trading rules designed to exploit visual patterns in financial series, such as head and shoulder pattern (Marshall et al., 2009). Jegadeesh (2000) showed that the mean returns generated by patterns are not significantly different from unconditional mean returns, implying that these trading rules can not be used as the basis for profitable technical strategy. Dawson and Steeley (2003) report a similar result to Jegadeesh (2000) when examining technical patterns in the UK stock market. Taylor (2003) suggested that future research should focus on Brock et al. (1992) technical trading rules; therefore, in our study, we examine the technical trading rules evaluated by Brock et al. (1992).

Table 2.1 Summary table of literature review (Technical trading rules in the stock markets)

Earlier studies of technical trading rules					
Authors	**Period**	**Markets**	**Technical trading rules**	**Methodology used**	**Main findings**
Alexander (1961)	1897-1959	US stock market	Filter rules	Compare technical trading returns to the simple buy-and-hold strategy	Technical rules yielded returns above the buy-and-hold returns.
Alexander (1964)	1897-1959	US stock market	Filter rules	Compare technical trading returns to the simple buy-and-hold strategy with the inclusion of transaction costs	Technical trading rules can not profit after transaction costs.
Fama and Blume (1966)	1956-1962	30 US Individual securities	Filter rules	Examine the profitability of trading rules, compare technical trading rules to a buy-and-hold strategy	Can not earn excess returns in excess of a buy-and-hold strategy.
Levy (1967a)	1960-1965	200 US listed securities	Relative strength rules	Compare trading returns to a simple buy-and-hold strategy	Trading rules performed better than a buy-and-hold strategy.
Levy (1968)	1962-1966	625 US listed securities	Relative strength rules	Compare trading returns to a simple buy-and-hold	Technical trading rules yielded higher returns.

				strategy	
Jenson and Benington (1970)	1960-1965	200 US listed securities	Relative strength rules	Compare trading returns to a simple buy-and-hold strategy	Technical trading rules can not earn returns more than buy-and-hold strategy.
Van Horne and Parker (1967)	1960-1966	30 US Industrial stocks	MA trading rules	Compare trading returns to a simple buy-and-hold strategy	None of 30 industrial stocks can earn higher returns than buy-and-hold strategy.
James, Jr. (1968)	1926-1960	US stock market	MA trading rules	Compare trading returns to a simple buy-and-hold strategy	Using a monthly moving average rules did not earn significant profits.
Empirical studies of technical trading rules in the developed stock markets					
Brock, Lakonishok, and LeBaron (1992)	1897-1986	US stock market	MA and TRB trading rules	Compare trading returns to a simple buy-and-hold strategy	Trading rules have predictive ability and can generate excess returns relative to a buy-and-hold strategy.
Hudson, Dempsey, and Keasey (1996)	1935-1994	UK stock market	MA and TRB trading rules	Compare trading returns to a simple buy-and-hold strategy with inclusion of transaction costs	Trading rules can predict stock price movements but earn trading profits depends on trading costs.
Bessembinder and Chan	1926-1991	US stock market	MA and TRB trading	Adjusted for	The inclusion of transaction costs

(1998)			rules	non-synchronous trading and transaction costs, used a "double or out" strategy to examine profitability of technical trading rules	and adjustment for non-synchronous trading eliminate trading profits.
Szakmary, Davidson, and Schwarz (1999)	1973-1991	US stock market	Filter and MA trading rules	Compare trading returns to a simple buy-and-hold strategy with inclusion of transaction costs	Trading rules for individual stocks performed poorly, but can earned excess returns for the market index, but these abnormal returns eliminated by transaction costs.
Allan and Karjalainen (1999)	1928-1995	US stock market index	MA trading rule	Used a genetic algorithm to test technical trading rules, and compared technical trading returns to the buy-and-hold returns	After transaction costs, the rules do not earn consistent excess returns over a simple buy-and-hold strategy.
Ready (1998)	1988-1992	US stock market index	MA and TRB trading rules	Transaction costs were taken into account, and compared trading returns to buy-and-hold returns	Technical trading rules can not beat buy-and-hold strategy to earn excess returns when transaction costs were included.
Kwon and Kish (2002)	1962-1996	US stock market index	MA trading rules	Daily return used to compute technical trading	Technical trading rules have weaker performance in the last sub-period,

				returns, and compared trading returns to returns earned by a buy-and-hold strategy	indicated that the US stock market was getting efficient over recent year.
Lento and Gradojevic (2007)	1995-2004	Toronto Stock Exchange (TSX), DJIA Index, NASDAQ Index, the Canada/US spot exchange rate	Filter rules, MA, Bollinger Bands, and TRB trading rules	Daily return used to compute technical trading returns, and compared trading returns to returns earned by a buy-and-hold strategy	Both MA and TRB were profitable for TSX, NASDAQ, Canada/US spot exchange after including transaction costs, no evidence of trading rules were useful for the DJIA Index.
Metghalchi and Glasure (2007)	1990-2006	Greek stock market index	TRB trading rule	Daily return used to compute technical trading returns, and compared trading returns to returns earned by a buy-and-hold strategy	TRB rules do indeed have predictive power, and can outperform buy-and-hold strategy.
Metghalchi, Glasure, Garza-Gomez, and Chen (2007)	1990-2006	Austrian stock market index	MA trading rule	Daily return used to compute technical trading returns, and compared trading returns to returns earned by a buy-and-hold strategy with the inclusion of transaction costs	Results indicated the profitability of technical trading rules for the Austrian stock market.

Mills (1997)	1935-1994	UK stock market index	MA and TRB trading rules	Daily return used to compute technical trading returns, and compared abnormal returns to transaction costs. A bootstrap methodology of AR-ARCH model was used	Technical trading rules can predict stock price movements and produce a return greater than a buy-and-hold strategy only in periods when the market was inefficient.
Chong and Ng (2008)	1935-1994	UK stock market index	Moving Average Convergence–Divergence (MACD) and the Relative Strength Index (RSI)	Daily return used to compute technical trading returns, and compared trading returns to returns earned by a buy-and-hold strategy	Before adjusted for transaction costs, both RSI and MACD rules could generate returns higher than the buy-and-hold strategy.
Bokhari, Cai, Hudson, and Keasey (2005)	1987-2002	100 UK stocks	MA and TRB trading rules	Examined the predictive ability and profitability of technical trading rules for different size company	Technical trading rules have higher predictive ability the smaller the size of the company, but are not profitable after accounting for transaction costs.
Vasiliou, Eriotis, and Papathanasiou (2008)	1995-2005	General Index of Athens Stock Exchange	MA trading rule	Daily return used to compute technical trading returns, and compared trading returns to returns earned by a buy-and-hold	Results found the predictive ability and Profitability of technical trading rules.

				strategy	
Chandrashekar (2005)	1963-2002	US stock market indices	MA trading rule	Examined the effectiveness of technical trading rules across firms of varying market capitalization	Technical trading rules were more appropriate to use for the small size companies; technical trading returns declined sharply in size.
Recent studies of technical trading rules focused on Asia-Pacific stock markets					
Bessembinder and Chan (1995)	1975-1989	Japan, Hong Kong, South Korea, Malaysia, Thailand, and Taiwan stock market indices	MA and TRB trading rules	Compare mean daily trading returns to the mean daily buy-and-hold returns to examine the predictive ability; a "double or out" strategy to examine the profitability of technical trading rules	Technical trading rules were successful in emerging stock markets of Malaysia, Thailand, and Taiwan; have less explanatory power in more developed stock markets of Hong Kong and Japan.
Ratner and Leal (1999)	1982-1995	India, Korea, Malaysia, Philippines, Taiwan, Thailand, Argentina, Brazil, Chile, and Mexico stock market indices	VMA trading rules	Daily inflation adjusted returns used to compute technical trading returns, and compare the excess returns after transaction costs	Technical trading rules can earn excess returns for stock markets of Taiwan, Thailand, and Mexico.
Ahmed, Beck, and Goldreyer (2000)	1994-1999	Taiwan, Thailand, and the Philippines stock market indices	VMA trading rules	Used ten VMA rules compared to a simple buy-and-hold strategy	Technical trading rules have predictive ability in emerging stock markets, and can generate profits even with the inclusion

					of transaction costs. For developed stock markets, it exhibited weak form market efficiency.
Gunasekarage and Power (2001)	1990-2000	Bangladesh, India, Pakistan, and Sri Lanka stock market indices	VMA and FMA trading rules	"Double or our" strategy used to examine profitability of technical trading rules	Ignoring transaction costs, technical trading rules could generate excess returns relative to a naïve buy-and-hold strategy for investors in the four emerging stock markets.
Parisi and Vasquez (2000)	1987-1998	Chile stock market index	MA and TRB trading rules	Compare excess returns of trading rules relative to buy-and-hold strategy after trading costs	Technical trading rules have predictive ability, due to high transaction costs in Chilean stock markets, technical trading rules can not earn profit for ordinary investors.
Lai, Balachandher, and Nor (2002)	1977-1999	Kuala Lumpur Stock Exchange (KLSE) Composite Index	VMA and FMA trading rules	Used variance ratio and multiple variance ratio to test random walk hypothesis, and follow Bessembinder and Chan (1995) to examine effectiveness of technical trading rules	Random walk hypothesis was rejected for the Malaysian stock market. Returns generated by the technical trading rules were significantly higher than the unconditional mean return of the buy-and-hold strategy even with transaction costs.
Achuthan and Anubhai (2005)	1991-2003	Indian stock market index	VMA trading rules	Compared excess returns of trading rules relative to	VMA trading rules do have predictive ability, but this ability was not supported when

				buy-and-hold strategy to trading costs	using a larger long-period MA rule. Due to high transaction costs incurred, trading rules can not earn profits.
Balsara, Chen, and Zheng (2007)	1990-2005	Chinese A-Share and B-Share of both Shanghai and Shenzhen stock market indices	MA, TRB, and Bollinger band trading rules	Examine random walk hypothesis and effectiveness of technical trading rules	Random walk hypothesis has been rejected And indicated that technical trading rules can generate profits in the two Chinese stock markets.
Wang and Li (2004)	1992-2003	Chinese A-Share and B-Share of both Shanghai and Shenzhen stock market indices, Hong Kong, Japan, US stock market indices	MA and TRB trading rules	Daily index return was used to compute technical trading return, and compared technical trading returns to the buy-and-hold returns	After controlling for non-synchronous trading and transaction costs, significant evidence was found to support the predictive ability and the profitability of technical rules for the Chinese foreign B-shares but not for the domestic A-shares and US stock market.
Coutts and Cheung (2000)	1985-1997	Hong Kong stock market index	MA and TRB trading rules	Daily index return was used to compute technical trading return; and compared excess returns of trading rules relative to buy-and-hold strategy to trading costs	Technical trading rules generated marginal abnormal returns before adjusting for transaction costs, but these disappeared for the MA rules with the inclusion of transaction costs.

Lam, Yeung, and Cheung (2007)	1972-2006	Hong Kong stock market index	MA and TRB trading rules	Daily index return was used to compute technical trading return; and compared excess returns of trading rules relative to buy-and-hold strategy to trading costs	Technical trading rules can generate excess returns, but these returns disappeared after adjusted for transaction costs.
Ito (1999)	1980-1996	Japan, Canada, Indonesia, Mexico, Taiwan, and US stock market indices	MA and TRB trading rules	Follow the same process proposed by Brock et al. (1992), and a "double or out" strategy used to examine the profitability of technical trading rules	Technical trading rules have strong predictive power for the emerging stock markets than for the developed stock markets, and trading rules were profitable relative to a buy-and-hold strategy after adjusting for transaction costs.
Marshall, Cahan, and Cahan (2009)	2001-2007	23 developed stock markets and 26 emerging stock market indices	MA and TRB trading rules	Daily index return was used to compute technical trading return; and compared excess returns of trading rules relative to buy-and-hold strategy to trading costs	Technical trading rules performed better in the emerging stock markets than in the developed stock markets.
Tian, Wan, and Guo (2002)	1926-2000 for the US;	US and the Chinese stock market indices	MA and TRB trading rules	Follow the same process proposed by Bessembinder	In the case of US, both MA and TRB trading rules have no predictability

	1992-2000 for the Chinese stock markets			and Chan (1995), and a "double or out" strategy used to examine the profitability of 412 technical trading rules	after 1975, but their results support the technical trading rules having both predictability and profitability for the Chinese stock market from 1992 to 2000.
Cai, Cai, and Keasey (2005)	1992-2003	US, UK, Japan, Hong Kong, Shanghai, and Shenzhen stock market indices	VMA and TRB trading rules	Extended Tian et al.'s (2002) process	For the US, technical trading rules had predictive ability during 1970's, but this ability largely disappeared by 1990's; for China, technical trading rules have short term predictive ability and could earn profits in the Chinese stock market.
Lento (2007)	1987-2005	Australia, India, Indonesia, Korea, Japan, Hong Kong, Singapore, and Taiwan stock market indices	MA, TRB, and filter rules	Daily index return was used to compute technical trading return; and compared excess returns of trading rules relative to buy-and-hold strategy to trading costs	Superior profits (after trading costs) can be achieved by technical trading rules over the simple buy-and-hold trading strategy in India, Hong Kong, Indonesia, Korea, Singapore, and Taiwan.

CHAPTER THREE

DATA AND METHODOLOGY

3.1. Introduction

This section discusses the data and methods used in examining the predictive ability and profitability of technical trading rules in the twelve Asia-Pacific stock markets. Section 3.2 describes the data sources. Section 3.3 reviews two technical trading rules (MA and TRB) and the selection of these rules. Section 3.4 introduces the methods used to test the predictive ability of the technical trading rules and Section 3.5 analyzes the methods used to test whether the technical trading rules can generate excess returns for investors. Section 3.6 investigates the relationship between market efficiency and excess returns by applying the technical trading rules. Section 3.7 concludes the chapter.

3.2. Data sources

This study analyzes the index of daily stock prices of twelve Asia-Pacific stock markets. The sample consists of twelve market indices (eleven countries but two stock market indices for China). Daily local index closing prices are obtained for the developed stock markets of Japan, Hong Kong, South Korea, Singapore, Australia, and New Zealand; and the emerging stock markets of Malaysia, Indonesia, Thailand, China, and the Philippines.[3] Table 3.1 describes the stock exchanges used in this study and the respective market capitalization and the number of listed companies. The daily local index closing prices are obtained from the main stock market index of

[3]The FTSE Group distinguishes between Advanced and Secondary Emerging markets on the basis of their national income and the development of their market infrastructure. List of emerging markets are available at http://en.wikipedia.org/wiki/Emerging_markets

each stock exchange, which contains the largest companies in each stock exchange and represent about 80% market capitalization of each stock exchange.

Table 3.1: Data description

Country	Stock Exchanges	Market Capitalization	Number of Listed Companies	Main Stock Market Index
		(USD millions)		
Australia	Australian SE	683,871.6	2009	All Ordinaries Index
China	Shanghai SE	1,425,354.0	864	Shanghai A-Share Index
	Shenzhen SE	353,430.0	740	Shenzhen A-Share Index
Hong Kong	Hong Kong Exchanges	1,328,768.5	1261	Hang Seng Index
Indonesia	Indonesia SE	98,760.6	396	Jakarta Composite Index
Japan	Tokyo SE Group	3,115,803.7	2390	Nikkei 225 Index
Malaysia	Bursa Malaysia	189,086.6	976	Kuala Lumpur Stock Exchange Composite Index
New Zealand	New Zealand Exchange	24,209.6	172	NZX ALL Index
Singapore	Singapore Exchange	264,974.4	767	Straits Times Index
South Korea	Korea Exchange	470,797.7	1793	Korea Composite Stock Price Index
Thailand	Thailand SE	103,128.2	525	SET Index
Philippines	Philippine SE	52,030.6	246	Philippine Stock Exchange Index

Source: World Federation of Exchanges (WFE), at December 31, 2008.

The Chinese stock market is unique in that there are two classes of shares, A and B shares traded on the two major Chinese Stock Exchanges (SHSE and SZSE). This study only uses the data from the Chinese A-share, including the Shanghai A- and Shenzhen A-share indices. As discussed before, we do not consider B-share since the B-share market is relatively small compared to the A-share market in terms of the number of listed firms and market capitalization.

Unlike the US and UK stock markets, long price histories of information are not available for the relatively new and emerging Asia-Pacific stock markets. This study therefore analyzes data from January 1, 1991 to December 31, 2008, a total of 18

years of daily data. In regards to the two Chinese stock indices, because the inflation rates are only available from February 1, 1994, the share price data used in this study covers the period February 1, 1994 to December 31, 2008. All data on price indices are obtained from Datastream database.

Given the high level of inflation experienced by many of the emerging markets, daily inflation adjusted returns are used to compute the technical trading profits. Annualized monthly inflation rates for each country are obtained from the International Financial Statistics database and Datastream database. Each annualised monthly inflation rate is divided by 240 to estimate the daily weekday inflation.[4] The daily return on day t is calculated by deducting the log value of the index on day t-1 (P_{t-1}) from its log value on day t (P_t). The formula is given as follows:

$$R_{i,t} = \left(\log_e\left[P_t\right] - \log_e\left[P_{t-1}\right]\right) - \left(\frac{INF_{i,m}}{240}\right) \qquad (3.1)$$

Where $R_{i,t}$ is the continuously compounded daily inflation adjusted return on day t for country i. $INF_{i,m}$ is the annualized monthly inflation for country i in month m when day t occurred.

3.3. Technical trading rules

The tests in our study involve observations of returns for the simple technical trading rules, and are compared with the returns earned by a simple buy-and-hold strategy.

[4] This assumes 12 months with 20 trading days in each month, approximate 240 trading days a year. We realize there are different open days, number of holidays and closures in these markets. However, we decide to use this number as an approximation for the number of trading days for a year. The actual number of trading days is around 240 per year.

We first describe the two simple technical trading rules evaluated by Brock et al. (1992) and Bessembinder and Chan (1995, 1998).

3.3.1. Moving average rules

Following Brock et al. (1992) and Bessembinder and Chan's (1995, 1998) framework, two of the simplest and most popular technical trading rules are investigated in this study: moving average and trading range breakout (resistance and support levels) rules. We now describe the two technical trading rules employed by these authors and address some issues related to the rules used.

Moving average trading rules (MA) are one of the most popular technical analysis tools. A moving average is an indicator that shows the average value of a security's price over a period of time. According to MA, buy and sell signals are generated by two different moving average periods: a long and a short period average. The simplest form of this strategy is to buy (sell) when the short-run moving average rises above (falls below) the long-run moving average (Brock et al., 1992). When the short-run moving average penetrates the long-run moving average, a trend is initiated. Using this technique, technical analysts make buy and sell decisions by comparing the short-run moving average of the share price with its long-run moving average counterpart. In general, these rules are identified by (short, long, band), where short and long are the lengths of periods for the short-run and long-run moving averages, respectively, and the band is the percentage difference between short and long moving averages required to generate a signal. The introduction of a band reduces the number of buy and sell signals by eliminating a signal when the short-run moving average is relatively close to the long-run moving average (Brock et al., 1992). If the short-run

moving average is inside the band, no signal is generated. If the band is zero, this method classifies all days into either buys or sells.

Brock et al. (1992) considered the technical trading rule with and without one percent band width. For example, a popular moving average rule is (1,50,0.01), for which the short period is 1 day (today's price) and the long period is 50 days, and a 1% band filter is applied, which indicates that a buy (sell) signal is only produced when the short-run moving average is at least 1% above (below) the long-run moving average. Traders may not only use bands of 0% and 1% but also use some higher bands. In our study, the moving average rules are tested with bands of 0%, 0.5%, 1%, and 3%.

There are two versions of the general moving average trading rules: the variable length moving average (VMA) and the fixed length moving average (FMA). According to Brock et al. (1992), VMA 'initiates buy (sell) signals when the short moving average is above (below) the long moving average by an amount larger than the band' (pp. 1735-1736). The VMA rule emphasises whether the short-run moving average is above (below) the long-run moving average, that is, the most recent price is above (below) the longer term price level. It further shows that the general trend in prices is upward (downward) (Gunasekarage and Power, 2001). Conventional users of this rule believe in long-term price trends, and that a new trend appears when the short-run average moves above or below the long-run moving average. To apply the rule, an investor should buy (sell) at the closing price of the trading day immediately after the short-term moving average exceeds (falls below) the long-run moving average. In testing the VMA rule, the short-run moving average periods are 1, 2, or 5 days, and the long-run moving average periods are 50, 150, or 200 days. Following

Brock et al.'s (1992) methodology, the test of the VMA rule is repeated by moving forward one day and dropping the first day in the moving average calculation.

The other version of the moving average rule is the fixed length moving average (FMA), which emphasises the crossing of the moving averages. The FMA rule stresses that returns should be different for a few days following a crossover. It focuses on the crossover of the long-run moving average by the short-run moving average. Brock et al. (1992) defined the FMA trading rule as "a buy (sell) signal is generated when the short-run moving average cuts the long-run moving average from below (above)" (pp.1736). Different from the VMA rule, the FMA rule calls for the investors to stay in the same position (either buy or sell) for a fixed number of days, usually 10 days once a buy or sell signal is detected. The returns for the next 10-days period are then recorded. Other signals occurring in the 10-days holding period are ignored. When the 10-days period passes, the FMA rule starts to generate a new signal only when the short-run and long-run moving average crosses again. In testing the FMA rule, the short-run moving average periods are 1, 2, or 5 days, and the long-run moving average periods are 50, 150, or 200 days.

Both these moving average rules imply that a variety of lengths for short and long periods and with bands of 0%, 0.5%, 1%, and 3% can produce variations. For each of the VMA and the FMA trading rules, this study examines twenty-four strategies, including (1,50,0), (1,50,0.005), (1,50,0.01), (1,50,0.03), (1,150,0), (1,150,0.005), (1,150,0.01), (1,150,0.03), (1,200,0), (1,200,0.005), (1,200,0.01), (1,200,0.03), (2,200,0), (2,200,0.005), (2,200,0.01), (2,200,0.03), (5,150,0), (5,150,0.005), (5,150,0.01), (5,150,0.03), (5,200,0), (5,200,0.005), (5,200,0.01), and (5,200,0.03).

3.3.2. Trading range breakout rules

The final technical rule tested in this study is the trading range breakout rule (TRB). This rule includes a "resistance" level and a "support" level. The resistance level is defined as a local maximum price. The support level is defined as a local minimum price (Brock et al., 1992). According to Brock et al. (1992), a buy signal is generated when the price penetrates the resistance level. According to the technical analysts, many investors are willing to sell at the peak, which causes a price increase above the previous peak. Once the price increases above the previous peak, it breaks through the resistance level, where the price may continue to move to a higher level. A breakout occurs, when the price increases above the previous peak, and is considered a buy signal.

Similarly, a sell signal is generated when the price penetrates the support level (Brock et al., 1992). It is difficult for the price to penetrate the support level because many investors are willing to buy at the minimum price. The buy pressure causes the price to increase above the support level. If the price falls below the support level, this suggests the price will drift further downward. However, if the price penetrates the previous peak (trough), an upward (downward) trend has started. In general, technical analysts suggest to buy when the price increases above its last peak and to sell when the price drops below its last trough.

To implement the trading range breakout strategy, this study evaluates the TRB rules in parallel with the moving average strategy. Maximum (minimum) prices are determined based on the past 50, 150, and 200 days. In addition, the rule is implemented with bands of 0%, 0.5%, 1%, and 3%. To test the TRB rules, an investor

buys (sells) at the closing price of the trading day immediately if today's closing price exceeds (falls below) the maximum (minimum) price level of the past 50, 150, or 200 days. The holding period returns will be recorded for 10 days after a buy or sell signal is generated. If today's closing price is between the local maximum and minimum price, no signal is generated. Investors do not take any action until a buy or sell signal is detected. Consistent with the MA rules, the long period of 50, 150, and 200 days are tested for the TRB rules. Twelve strategies are examined in this rule, including (1,50,0), (1,50,0.005), (1,50,0.01), (1,50,0.03), (1,150,0), (1,150,0.005), (1,150,0.01), (1,150,0.03), (1,200,0), (1,200,0.005), (1,200,0.01), and (1,200,0.03).

The formulas for buy and sell signals for the TRB rule are given as follows:

$$P_t > (1+X)\ \text{Max}\ (P_{t-1,\ldots}\ P_{t-m}) = \text{Buy} \qquad (3.2)$$

$$P_t < (1+X)\ \text{Min}\ (P_{t-1,\ldots}\ P_{t-m}) = \text{Sell} \qquad (3.3)$$

where P_t is the closing price at day t; m is the chosen period (50, 150, 200 days); X is the percentage of band (X=0 or 0.01).

3.4. Predictive ability of technical trading rules

This section introduces the methodology used to examine the predictive ability of technical trading rules. Brock et al. (1992) indicated that the technical trading rules have predictive ability when the buy signals generate positive returns and the sell signals generate negative returns, which on average, are significantly different from the returns earned by a simple buy-and-hold strategy. To evaluate the predictive

ability of the technical trading rules, this study replicates Brock et al.'s (1992) process. Technical trading rules are determined to be effective if the buy signals earned positive returns and the sell signals earned negative returns, and are statistically significantly different from the returns earned by a simple buy-and-hold strategy. Hypothesis 1 is proposed as follows:

Buy signals earn positive returns and sell signals earn negative returns, and the mean daily buy and sell returns generated by the technical trading rules are significantly different from the returns earned by a buy-and-hold strategy.

In our study, two versions of the MA (VMA and FMA) and the TRB rules are examined. To evaluate the predictive ability of these trading rules, Hypothesis 1 is tested. For the VMA rule, the mean daily returns generated by the buy and sell signals are calculated, as well as the unconditional mean daily returns generated by a simple buy-and-hold strategy. Following this, the mean daily buy and sell returns are compared with the mean daily returns on the simple buy-and-hold strategy for the testing period. If the mean daily returns generated by the buy signals are positive and by the sell signals are negative and are statistically significantly different from the mean daily returns on the simple buy-and-hold strategy, this implies that the VMA trading rules have predictive ability. On the other hand, the FMA rule examines a fixed 10-day holding period returns after each cross-over of the short-run and long-run moving averages. The returns are then compared with the unconditional 10-day returns (buy-and-hold returns) for each of the test periods. The trading range breakout rule is considered next. With the TRB rule, the buy and sell signals are generated when the price level moves above or below local maxima or minima. Local maxima and minima are computed over the preceding 50, 150, or 200 days. The TRB rule is similar to the FMA rule, since it has 10-day holding period returns following

the buy or sell signals. For both the FMA and TRB rules, if the mean 10-day buy returns generated by those two technical trading rules are positive and the mean 10-day sell returns are negative and are statistically significantly different from the unconditional mean 10-day returns, it implies that both the FMA and TRB trading rules have predictive ability.

The significance of the returns generated by the technical trading rules is examined using a t-test. The formula of the t-statistic for the mean buy (sell) returns is given as follows:

$$\frac{\mu_r - \mu}{(\sigma^2 / N + \sigma^2 / N_r)^{1/2}} \qquad (3.4)$$

Where μ_r and N_r are the mean returns and the number of signals for the buys and sells respectively, and μ and N are the unconditional mean returns and the number of observations respectively, and σ^2 is the estimated variance for the whole sample.

The t-statistic for the buy-sell difference is calculated using the following formula:

$$\frac{\mu_b - \mu_s}{(\sigma^2 / N_b + \sigma^2 / N_s)^{1/2}} \qquad (3.5)$$

Where μ_b and N_b are the mean returns and the number of signals for the buys respectively, and μ_s and N_s are the mean returns and the number of signals for the sells respectively, and σ^2 is the estimated variance for the entire sample.

This study uses a two-tailed t-test, where the null hypotheses will be rejected when the value of the t-statistic is either sufficiently small or sufficiently large. A two-tailed t-test compares the absolute value of test statistic of the critical value. If the absolute value is greater than the critical value, the null hypothesis is rejected in favour of the alternative hypothesis, and vice versa. In summary, if the buy returns earned by technical trading rules are positive and sell returns are negative and statistically significantly different from the passive buy-and-hold strategy returns, then the returns earned by the technical trading rules are equal to those achieved by a simple buy-and-hold strategy. This demonstrates the predictive ability of these technical trading rules.

3.5. Profitability of technical trading rules

A "double or out" strategy used by Brock et al. (1992) and Bessembinder and Chan (1995, 1998) is adapted in our study to measure the profitability of technical trading rules in a costly trading environment. Under this strategy, investors borrow at the risk-free rate to double their investments in the index with a buy signal, and sell and invest in a risk-free asset with a sell signal. However, the investors will hold a long stock position when there is neither a buy or sell signal. The investors make profits when they invest in a buy signal by staying in the rising stock market (bull market). Similarly, they sell their investments in a sell signal and make profits by leaving the

declining stock market (bear market). For example, let R denote the index return and i is the daily risk-free interest rate. Under a "double or out" strategy, a trader reacts to buy signals by borrowing money at risk-free interest rate i to double his/her investments. A pre-transactions cost trading returns on buy days are $TR_i=2R_i-i_i$. The trader reacts to sell signals by liquidating any equity holdings and investing in risk-free assets, leading to sell days trading returns of $TR_j=i_j$.

In this study, the risk-free interest rate is assumed to be zero. In addition, daily risk-free interest rate data for these markets are not available. It is common to use a zero interest rate because of the complex difference between borrowing and saving rates, and the possibility of investors using arbitrage portfolios (Cai et al., 2005). Bessembinder and Chan (1995, 1998) argued that the bias created by a zero interest rate is relatively small compared to the magnitude of the buy versus sell day returns.

In the absence of transactions costs, the additional return (π) generated by technical trading rules relative to a buy-and-hold strategy is given as follows:

$$\begin{aligned}\pi &= \sum_{i=1}^{N_b}(BR_i - R_i) + \sum_{j=1}^{N_s}(SR_j - R_j) \\ &= \sum_{i=1}^{N_b}(2R_i - R_i) + \sum_{j=1}^{N_s}(o - R_j) \\ &= \sum_{i=1}^{N_b}(R_i) - \sum_{j=1}^{N_s}(R_j)\end{aligned} \tag{3.6}$$

Where BR_i is the trading returns on days the buy position is held

SR_j is the trading returns on days the sell position is held

N_b is the number of days the buy position is held

N_s is the number of days the sell position is held

R_i is the index return on day i

R_j is the index return on day j

In general, a trader would incur transaction costs. Following Bessembinder and Chan (1995, 1998), the round-trip breakeven cost (C) is calculated as follows:

$$C = \frac{\pi}{n_b + n_s} \tag{3.7}$$

Where n_b and n_s is the number of buy and sell signals generated, respectively.

The breakeven costs are the percentage costs needed to offset the additional returns from technical trading. To evaluate the profitability of technical trading rules, we follow the same procedure proposed by Bessembinder and Chan (1998). Hypothesis 2 is proposed as follows:

The estimated breakeven cost for the technical trading rule is greater than the estimated actual transaction cost.

We calculated the breakeven cost required to offset the additional returns generated by technical trading relative to a buy-and-hold strategy. The estimated breakeven cost is then compared with the estimated actual transaction cost to test whether using the technical trading rules can generate excess returns for investors across different time periods in the Asia-Pacific stock markets. If the estimated breakeven costs for the technical trading rules are greater than the estimated actual transaction for the stock markets we tested, this implies that the technical trading rules are profitable.

In addition, this study also tests the returns forecast ability reported in Brock et al.'s (1992) study that could simply reflect measurement error in portfolio returns due to non-synchronous reporting of prices, which induces spurious positive autocorrelation in index price changes (Scholes and Williams, 1977). The Asian equity markets are characterized by relatively low volume and non-synchronous trading (or thin trading) (Bessembinder and Chan, 1995). This reflects small trading in the equity market because of a lack of buy or sell order to drive up the volume. For example, Scholes and Williams (1977) showed that the non-synchronous trading of component securities induces spurious positive serial dependence in measured index returns. The technical trading rules rely on positive serial dependence and may reflect return measurement errors. Following the approach of Bessembinder and Chan (1995, 1998), our study corrects for the possibility of non-synchronous trading to minimize the measurement errors. We measure the buy and sell day returns by implementing a one-day lag, whereby the returns earned by the technical trading rules are measured with the closing index value one day after a technical signal is initiated. Therefore, once a buy (sell) signal is generated, the investor will buy (sell) on the following day and returns are calculated based on the market returns.

3.6. Relationship between market efficiency and profitability of technical trading rules

Our investigation of the technical trading rules over twelve stock markets enables us to make important comparisons between the developed and emerging stock markets. Prior studies in this area showed that the random walk hypothesis can be rejected in many emerging stock markets, implying that the technical trading rules may be more profitable than they are in the developed stock markets (Bessembinder and Chan,

1995; Ahmed et al., 2000; Tian et al., 2002; Chaudhuri and Wu, 2003; Marshall et al., 2009). As discussed earlier, many Asian stock markets are dominated by a few large companies with ownership concentrated in the hands of a small number of investors, and the probability of insider trading is relative high. These Asian markets are not as informationally efficient as the US or European stock markets. If the Asia-Pacific stock markets are in fact relatively inefficient, then the technical trading rules may be able to exploit the inefficiencies. To test the relationship between market efficiency and profitability of the technical trading rules, we compare the technical trading rules returns over twelve stock markets with different levels of development. Hypothesis 3 is proposed as follows:

Technical trading rules are more profitable in the emerging stock markets than in the developed stock markets.

3.7. Conclusion

Chapter three describes the data and methods used in this study. We examine the predictive ability and profitability of the simple technical trading rules in twelve Asia-Pacific stock markets. Given the high level of inflation experienced by many emerging markets, daily inflation adjusted returns are used to compute the technical trading profits. Two simple types of technical trading rules are examined in this study, the moving average trading rules (MA) and the trading range breakout rules (TRB). There are two versions of the general moving average trading rules: the variable length moving average (VMA) and the fixed length moving average (FMA). In this study, the short-run moving average periods for the VMA and FMA are 1, 2, or 5 days, and the long-run moving average periods are 50, 150, or 200 days. The short

period for the TRB rules is always one day (today's price), and the long periods are 50, 150, or 200 days. All trading rules are implemented with and without bands of 0%, 0.5%, 1% and 3%. In addition, we consider a 10-day holding period after a signal is initiated for the FMA and TRB trading rules.

To evaluate the predictive ability of the technical trading rules, this study follows Brock et al.'s (1992) procedure. If the mean buy returns generated by the technical trading rules are positive and mean sell returns are negative, and are statistically significantly different from the mean buy-and-hold returns, we can conclude that the technical trading rules have predictive ability.

In measuring the profitability of the technical trading rules in a costly trading environment, a "double or out" strategy is used. Under this strategy, a trader reacts to the buy signals by borrowing money to double his/her investments and to the sell signals by liquidating any equity holdings and investing in risk-free assets. We estimate the breakeven costs (that are the percentage costs) required to eliminate the additional returns from technical trading. The estimated breakeven cost is then compared with the estimated actual transaction cost to test whether using technical trading rules can generate excess returns for investors across different time periods in the Asia-Pacific stock markets. In addition, to minimize the measurement errors due to non-synchronous trading, this study measures buy and sell day returns with a one-day lag return.

Since the study investigates the technical trading rules in twelve stock markets with varying levels of development, it enables us to make important comparisons between

the developed and emerging stock markets. In order to test the relationship between market efficiency and profitability of the technical trading rules, we compare the technical trading rules returns over the twelve stock markets with different levels of development.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Introduction

This chapter discusses the empirical results and findings. Summary statistics are presented in Section 4.2. Section 4.3 reports the results of the variable-length moving average trading rules (VMA) and Section 4.4 reports the results for the fixed-length moving average trading rules (FMA). Section 4.5 presents the results for the trading range break-out trading rule (TRB) while Section 4.6 analyses the profitability of technical trading rules. Section 4.7 discusses the relationship between market efficiency and the profitability and Section 4.8 concludes the chapter.

4.2. Summary statistics

Table 4.1 reports the summary statistics for the mean daily and 10-day non-overlapping returns for the twelve price series indices for the entire sample during the period from January 1, 1991 to December 31, 2008. For the two Chinese stock markets, the stock price index data are obtained for February 1, 1994 to December 31, 2008. Returns are calculated as log differences of these stock indices. These include the average buy-and-hold returns for each stock market during the entire sample period. Panel A and B in Table 4.1 shows the mean daily inflation adjusted returns and the raw mean daily returns (unadjusted inflation), respectively. Panel C and D shows the 10-day inflation adjusted returns and the raw 10-day returns (unadjusted inflation), respectively. In Panel A and C, the mean daily and 10-day inflation adjusted returns for all the stock markets are positive except for the Japanese and Thailand stock markets; and the raw mean daily returns and 10-day returns shown in Panel B and D, respectively are similar to those reported in Panel A and C. The

mean daily inflation adjusted returns for the emerging stock markets, on average, outperform the developed stock markets over the sample period of our study in Panel A (mean daily inflation adjusted returns of 0.016% for emerging stock markets versus 0.011% for developed stock markets). Panel B shows similar results, where the raw mean daily returns for the emerging stock markets, on average, outperform the developed stock markets over the sample period (raw mean daily returns of 0.0172% for the emerging stock markets versus 0.0114% for the developed stock markets). The results show that the mean daily returns in Panel B are similar but slightly higher than those in Panel A. The difference between the two panels is very small. For the 10-day returns in Panel C and D, the results are similar to those in Panel A and B. The mean 10-day inflation adjusted returns in Panel C are similar but slightly lower than the raw mean 10-day return (not adjusted for inflation) in Panel D. The mean 10-days returns for the emerging stock markets, on average, outperform the developed stock markets counterpart (see Panel C and D in Table 4.1).

Emerging stock markets outperform the developed stock markets, on average, but they are associated with high risks. The standard deviations (volatility) of the mean daily returns and the mean 10-day returns are higher for the emerging stock markets than for the developed stock markets. The Chinese stock markets are the most risky, based on the reported standard deviations; while the Australian and New Zealand stock markets are the least risky markets (see Table 4.1).

The returns for these stock markets are not normally distributed. Five of the twelve market indices displayed negative skewness in both panels while the returns for all the markets are strongly leptokurtic (Kurtosis are high). The Jarque-Bera statistic tests the

normality of large sample using both skewness and kurtosis measures. The tests show that all the markets statistically significantly deviate from normality in their security returns. This finding does not impact our results for the technical trading rules. The market index returns are not normally distributed during the period 1991 to 2008, but the buy (sell) returns generated by the technical trading rules may be normally distributed. In addition, non-normality of the series are also demonstrated in Ratner and Leal's (1999) findings, who examined the technical trading rules in ten emerging stock markets and Gunasekarage and Power (2001) who tested the technical trading rules in four South Asian stock markets.

Finally, the series autocorrelations of the mean daily returns demonstrated strong dependence. The autocorrelation of the inflation adjusted series is nearly the same as the inflation unadjusted series. Thus, the construction of the inflation adjusted series does not introduce a serial correlation bias into the data. In both Panel A and B (Table 4.1), nine out of the twelve markets indices demonstrate significant positive first-order autocorrelations. According to Ratner and Leal (1999), the larger the magnitude of the autocorrelation coefficient, the greater the potential of market inefficiency. Significant first-order autocorrelation is observed in Australia, New Zealand, Korea, Singapore, Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets. This study uses technical trading to exploit the inefficiency in these markets. For the mean 10-day returns, the autocorrelations for the twelve stock markets are small compared to the mean daily returns. Six out of twelve stock market indices demonstrate significant positive first-order autocorrelations, especially New Zealand, Singapore, Indonesia, Thailand, Shenzhen, and the Philippines.

Table 4.1 Descriptive statistics of the study sample

Table 4.1 shows the descriptive statistics for the entire samples. The *** indicates statistical significance at the 1% level, ** at the 5% level and * at the 10% level for a two-tailed test. Ljung-Box q-statistics are provided in parentheses. The Jarque-Bera statistic tests the normality of large samples using both skewness and Kurtosis measures.

	Developed Stock Markets						Emerging Stock Markets					
	Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	China (SHSE)	China (SZSE)	Philippines
Panel A: Daily inflation adjusted return												
Mean (%)	0.0215*	0.0104*	-0.0212*	0.0323**	0.0087**	0.0127*	0.0107***	0.0213***	-0.0077**	0.0237***	0.0273***	0.0202***
SD.	0.0090	0.0086	0.0150	0.0168	0.0188	0.0131	0.0145	0.0154	0.0168	0.0218	0.0222	0.0152
Skew.	-0.6507	-0.6501	-0.1188	0.0067	-0.1225	0.0931	0.4248	-0.1513	0.0807	1.5370	0.8253	0.2947
Kurt.	11.7527	57661.26	8.8848	13.4876	7.5396	12.9918	47.4273	12.5043	9.9324	29.6457	22.3343	12.6508
Jar-Be.	15324.5***	54728.1***	6788.5***	21525.8***	4044.9***	19545.5***	386426.9***	17696.6***	9410.5***	116639.6***	61062.4***	18295.8***
Autocorrelation												
Lag 1	0.012*	0.033**	-0.023	-0.002	0.045***	0.095***	0.064***	0.182***	0.088***	-0.013	0.026*	0.167***
Lag 2	-0.039	0.024**	-0.056	-0.012	-0.013	0.006***	0.035***	0.041***	0.046***	0.018**	0.016*	0.005***
Lag 3	-0.028	-0.001	-0.018	0.033*	-0.006	0.001***	0.023***	-0.001	0.015***	0.04**	0.042**	-0.003
Lag 4	0.019***	0.004*	0.015***	-0.015	-0.024	0.01***	-0.079	-0.024	0.007***	0.043***	0.077***	0.02***

Lag 5	0.019***	0	0.013***	-0.025	-0.031	-0.015	0.055***	-0.005	0.019***	0.022***	0.009***	-0.02
Panel B: Raw daily return (not adjusted for inflation)												
Mean (%)	0.022*	0.0112*	-0.0211*	0.033**	0.0102**	0.0132*	0.0117***	0.0251***	-0.0065**	0.0232***	0.0269***	0.0225***
SD.	0.0090	0.0086	0.0150	0.0168	0.0188	0.0131	0.0145	0.0154	0.0168	0.0218	0.0222	0.0152
Skew.	-0.6525	-0.6504	-0.1191	0.0068	-0.1225	0.0931	0.4253	-0.1455	0.0803	1.5383	0.8261	0.2952
Kurt.	11.7684	20.1160	8.8831	13.4842	7.5415	12.9891	47.4332	12.5067	9.9356	29.6607	22.3395	12.6533
Jar-Be.	15376.9***	57665.5***	6783.2***	21507.4***	4048.3***	19534.8***	386530.1***	17700.4***	9419.1***	116801.6***	61095.8***	18305.6***
Autocorrelation												
Lag 1	0.011*	0.033**	-0.023	-0.002	0.045***	0.095***	0.064***	0.181***	0.088***	-0.013	0.026*	0.167***
Lag 2	-0.039	0.024**	-0.056	-0.012	-0.013	0.006***	0.035***	0.04***	0.046***	0.018**	0.016*	0.005***
Lag 3	-0.028	-0.001	-0.018	0.033*	-0.006	0.001***	0.023***	-0.001	0.015***	0.04**	0.042**	-0.003
Lag 4	0.019***	0.004*	0.015***	-0.015	-0.024	0.01***	-0.079	-0.024	0.007***	0.043***	0.077***	0.02***
Lag 5	0.018***	0.003*	0.013***	-0.025	-0.031	-0.015	0.055***	-0.005	0.019***	0.022***	0.009***	-0.02
Panel C:10-day inflation adjusted return												
Mean (%)	0.2263*	0.0986*	-0.24*	0.362*	0.2619*	0.1639*	0.2057*	0.298**	0.07*	0.4577*	0.4732**	0.2567*
SD.	0.02796	0.029	0.0474	0.0553	0.0602	0.0447	0.05	0.0561	0.0605	0.0698	0.0759	0.0554
Skew.	-0.762618	0.1132	-0.7602	-1.2568	-0.3031	-0.8635	0.8	-0.6522	0.1108	1.3234	0.6645	-0.1977
Kurt.	7.1335	5.0377	8.9108	11.5068	6.7295	7.97	13.59	6.6485	5.4662	12.02	7.5773	5.4998

Jar-Be.	378.54***	81.97***	726.35***	1534.3***	278.4***	539.8***	2236.2***	292.8***	119.56***	1428.3***	367.3***	124.9***
Autocorrelation												
Lag 1	-0.054	0.022	-0.003	-0.019	-0.021	0.013	-0.015	0.024**	0.129***	-0.023	0.027*	0.127***
Lag 2	-0.008	0.007	-0.064	0.045	0.065	0.044	0.003	0.13**	-0.036	0.071	-0.007	0.035**
Lag 3	-0.06	-0.159	0.004	-0.043	0.065	0.05	0.055	0.042**	0.006**	-0.028	0.03	-0.053
Lag 4	0.015	-0.032	0.013	0.019	0.007	0.086	0.064	-0.052	0.003*	0.016	-0.006	0.098***
Lag 5	0.028	0.029**	-0.013	-0.01	-0.057	0.011	0.003	-0.075	-0.034	0.028	0.012	-0.045
Panel D: Raw 10-day return (not adjusted for inflation)												
Mean (%)	0.2272*	0.0994*	-0.239*	0.363*	0.2632*	0.1645*	0.2067*	0.3019**	0.0713*	0.4573*	0.4727**	0.2589*
SD.	0.028	0.029	0.0474	0.0553	0.0602	0.0447	0.05	0.0561	0.0605	0.0698	0.0759	0.0554
Skew.	-0.7628	0.1131	-0.7604	-1.2565	-0.3032	-0.8633	0.8	-0.6511	0.1105	1.3236	0.6647	-0.1975
Kurt.	7.1348	5.0375	8.9106	11.5049	6.7309	7.9683	13.59	6.6503	5.4676	12.02	7.5779	5.5011
Jar-Be.	378.77***	81.95***	726.33***	1533.7***	278.6***	539.5***	2236.04***	292.9***	119.68***	1428.6***	367.4***	125.02***
Autocorrelation												
Lag 1	-0.054	0.022	-0.003	-0.019	-0.021	0.013	-0.015	0.024**	0.129***	-0.023	0.027*	0.127***
Lag 2	-0.008	0.007	-0.064	0.045	0.065	0.044	0.003	0.13**	-0.036	0.071	-0.007	0.035**
Lag 3	-0.06	-0.159	0.004	-0.043	0.065	0.05	0.055	0.042**	0.006**	-0.028	0.03	-0.053

Lag 4	0.015	-0.032	0.013	0.019	0.007	0.086	0.064	-0.052	0.003*	0.016	-0.006	0.098***
Lag 5	0.028	0.029**	-0.013	-0.01	-0.057	0.011	0.003	-0.075	-0.034	0.028	0.012	-0.045

4.3. Results of the variable-length moving average rules (VMA)

Table 4.2 shows the results from trading strategies based on the variable-length moving average trading rules for each market index. The rules differ by the length of the short and long period and the size of the band. Trading rules are described as (short, long, band). For example, the (1,50,0) rule indicates that the short-run period is one day, the long-run period is 50 days, and the band is zero percent. The variable-length moving average rule is used to divide the whole sample into either buy or sell periods depending on the relative position of the moving average. If the short-run moving average rises above (falls below) the long-run moving average, the day is classified as a buy (sell) signal. The VMA rule is designed to generate returns from a trading rule where the trader buys when the short-run moving average penetrates the long-run moving average from below and remains in the market until the short-run moving average penetrates the long-run moving average from above. Following this signal, the trader moves out of the market.

If the technical trading rules do not have predictive power to forecast share price movements, then we should observe that the returns on days when the rules generate buy signals do not differ from returns on days when the rules generate sell signals. To evaluate the forecasting power of the technical trading rules, we compare the mean returns on buy versus sell days for each rule we examined. Table 4.2 reports the VMA results for twelve stock markets and the mean buy-and-hold returns for each market. Panel A in Table 4.2 reports the number of buy and sell signals, the mean daily inflation adjusted returns on buy and sell days with corresponding t-statistics (in parentheses), and the differences between the buy and sell returns with associated t-statistics (in parentheses); while Panel B reports the corresponding results for the

raw mean daily returns on buy and sell days. At the bottom of Table 4.2, we report the average returns on buy and sell days computed for all VMA rules for each of the 12 market indices, and the buy-sell differences with the associated t-statistics. In this study, we use bands of 0%, 0.5%, 1%, and 3%, generating a total of 24 VMA rules. The trading band filters out small fluctuations in the series share price data and avoids generating false signals when the short-run and long-run moving averages are close to each other. In our study, the VMA trading rules with band of 0.5% generate similar number of signals as a band of 1%. Similarly, the returns generated by the VMA rules with band of 0.5% are similar to the returns generated by the VMA rules with band of 1%. The VMA trading rules with band of 3% generate less number of signals than rules with bands of 0.5% and 1%, but give the highest returns compared to others. Our results show that the trading profits are larger for trading rules with higher band, presumably because it generates smallest number of signals. For example, the mean daily returns generated by the VMA rules of (1,50,0.005), (1,50,0.01) and (1,50,0.03) for the Malaysian stock markets are 0.17%, 0.19%, and 0.24%, respectively. Despite the VMA trading rules with band of 3% could generate higher returns than rules with bands of 0.05% and 1%, our results show that majority of the trading rules with a band of 3% can only generate small number of signals, especially for the fixed length moving average (FMA) and the trading range breakout (TRB) rules. For example, the TRB rules with a 3% band can not generate any signals for the Australian stock markets. Therefore, a one percent band is more appropriate in our study. Here, we only present results of the technical trading rules with the bands of 0% and 1%, a total of 12 rules out of the 24 VMA rules examined in this study. The results for the VMA trading rules with bands of 0.5% and 3% are documented in the Appendix 1.

The results of Panel A in Table 4.2 show that the average number of buy signals are 50 percent more than the sell signals for Australia, New Zealand, Hong Kong, Korea, Singapore, Malaysia, Indonesia, Shanghai, and the Philippines stock markets; while the average number of buy signals are similar to the sell signals for Japan, Thailand, and Shenzhen stock markets. These results are consistent with the upward-market trend of the Asia-Pacific markets during the sample period. Brock et al. (1992) indicated that the buy signals earned positive returns and sell signals earned negative returns, and are statistically significantly different from returns earned by a buy-and-hold strategy. For the trading rules to be effective, the average buy returns must be positive and the average sell returns must be negative, and are statistically significantly different from the unconditional returns (buy-and-hold returns). This study employs significance levels of 1%, 5%, and 10%.

In Panel A of Table 4.2, majority of the buy returns are positive and the sell returns are negative across the twelve stock market indices. Out of the 144 VMA rules tested for all markets (12 stock market indices with 12 VMA rules each), 46 VMA rules (or 32% of the VMA rules) show positive buy returns and negative sell returns, and are statistically significantly different from those available to investors who follow a passive buy-and-hold strategy. For the more developed stock markets, all buy returns are positive but only 7 VMA rules (in HK, Korea, and Singapore) out of 72 (6 stock market indices with 12 VMA rules each) are significant. The Hong Kong and Korea stock market indices each have two significant rules, namely (1,50,0) and (1,50,0.01). Singapore stock market index has three significant rules, namely (1,50,0), (1,50,0.01) and (1,150,0.01). This shows that the VMA rules have short term period predictive ability for the developed stock markets of Hong Kong, Korea, and Singapore.

For the emerging stock markets, 39 VMA rules (or 54% of the VMA rules) out of 72 (6 stock market indices with 12 VMA rules each) are significant. Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock market demonstrate the most potential profits across the twelve VMA rules. The average buy (sell) returns across the twelve VMA rules are: 0.08% (-0.07%) for the Malaysian market, 0.1% (-0.07%) for Indonesia, 0.07% (-0.08%) for Thailand, 0.14% (-0.07%) for Shenzhen, and 0.08% (-0.07%) for the Philippines stock markets. The average 1-day buy-and-hold returns are 0.0107%, 0.0213%, -0.0077%, 0.0273%, and 0.0202% for Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets, respectively. The average buy and sell returns for the five stock markets clearly show that the buy returns are positive and sell returns are negative and are statistically significantly different from the returns earned by the buy-and-hold strategy. In addition, for the Chinese stock markets, the Shanghai index has two significant rules and the Shenzhen index has six significant rules. All these significant rules are the short term variants of the VMA rules. For example, the significant VMA rules for the Shanghai stock market are (1,50,0) and (1,50,0.01), the short period is 1 day and the long period is 50 days. For the longer term variants of VMA rules, like the short period is 2 or 5 days and the long period is 150 or 200 days, are insignificant.

The result is not unexpected given the stronger predictive power of the emerging stock markets revealed by Harvey (1995b) and Ratner and Leal (1999). In fact, Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets present majority of the significant VMA rules. When we perform tests with 1-day lag returns, the average buy and sell return figures are very close to those of Bessembinder and Chan (1995) and Ratner and Leal (1999) results for Malaysia, Thailand, and the

Philippines stock markets; Lento (2007) for the Indonesia stock market; and Cai et al. (2005) for the Shenzhen stock market. Our results clearly support our Hypothesis 1 that the average buy returns must be positive and the average sell returns must be negative, and are statistically significantly different from the buy-and-hold returns. This implies that the VMA rules have predictive ability in the five Asia-Pacific stock markets of Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines.

A comparison of the different VMA rules across the 12 market indices in Table 4.2 reveals that, the (1,50,0) and (1,50,0.01) are the most profitable VMA trading rules for all the markets. On the buy and sell sides, the VMA rule (1,50) is the best performing trading rule with the highest significant average returns across all market indices. As the length of the long-run moving average period increases, the profit generated from the VMA trading rules declines. For example, a comparison of the (1,50,0), (1,150,0), and (1,200,0) VMA rules for the Thailand stock market shows that the overall buy-sell profit falls from 0.23% to 0.12% as the long-run moving average period varies from 50 to 200 days. In addition, as the length of the short-run moving average increases the buy-sell profit declines. For example, a comparison of the (1,200,0), (2,200,0), and (5,200,0) VMA rules for Thailand stock market shows that the buy-sell profit falls from 0.14% to 0.06% as the short-run moving average increases from 1 to 5 days. Gunasekarage and Power (2001) reported the similar results of the VMA trading rules for four South Asian stock markets (Bangladesh, India, Pakistan, and Sri Lanka); and Cai et al. (2005) also presented the similar conclusions for the two Chinese stock markets. These results show the short term variants of the VMA trading rules have stronger predictive ability and profitability for the emerging stock markets. Achuthan and Anubhai (2005) in their study of the Indian

stock markets also showed that the VMA rules with short-term period have predictive ability. This is because the moving average rules with short term period due to their ability to react and capture the market trends quickly.

Our result is consistent with Bessembinder and Chan (1995), Gunasekarage and Power (2001), and Lento (2007), where the largest profit is always achieved by the trading rules with a band of 1%, presumably because it generates the smallest number of signals. The introduction of the one percent band reduces the number of signals generated by the trading rules and increases the spread of the buy and sells returns. Thus, the technical trading returns would be larger with a band of 1% compared to those generated by trading rules without band.

Panel B in Table 4.2 reports the raw mean daily returns of the buy and sell signals generated by the VMA trading rules. The results are similar to Panel A, Panel B only presents the VMA rules with bands of 0% and 1%, generating a total of 12 VMA trading rules. The returns generated by the 12 VMA rules in Panel B are similar to those in Panel A. For example, the average buy (sell) return of 0.068% (-0.050%) across all 12 market indices and all VMA trading rules in Panel B compared to 0.067% (-0.050%) in Panel A. The difference between Panel A and B results is that the average buy and sell returns in Panel B are slightly higher than those in Panel A. This is because the returns generated in Panel A have been adjusted for inflation. When the daily returns are adjusted for inflation the technical trading profits are nearly the same with the raw daily returns.

Furthermore, Panel B results show similar significant rules with those achieved in Panel A for each of the market index. For example, for the emerging stock markets, Panel B results show the same five stock market indices demonstrate major significant VMA rules with those in Panel A, namely Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines. Therefore, for a more robust result, we only use the daily inflation adjusted returns in our discussion of the remaining trading rules (FMA and TRB rules).

In summary, our results reveal that the VMA trading rules do have considerable predictive ability to forecast price changes in the Asia-Pacific stock markets. In calculating the technical trading returns, our results show that inflation adjusted returns are similar to the unadjusted returns when we compare both returns. To evaluate the predictive ability of the VMA rules, our results show that the VMA rules can beat the buy-and-hold strategy to generate excess returns without transaction costs in Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets. Majority of the VMA rules are insignificant for the developed stock markets of Australia, New Zealand, Japan, Hong Kong, Korea, and Singapore. This implies that these developed stock markets support the weak-form EMH and using the VMA technical trading rules can not be profitable.

Table 4.2 Standard test results for the variable-length moving average (VMA) rules

Panel A: VMA rules adjusted for inflation													
		Developed Stock Markets						Emerging Stock Markets					
		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns (%)		0.0215%	0.0104%	-0.021%	0.0323%	0.0087%	0.0127%	0.0107%	0.0213%	-0.008%	0.0237%	0.0273%	0.0202%
Rules													
(1,50,0)	N(Buy)	2913	2557	2204	2795	2418	2567	2554	2650	2310	1937	1917	2488
	N(Sell)	1733	2089	2442	1851	2228	2079	2092	1996	2336	1904	1924	2158
	Buy	0.0004	0.00025	0.00007	0.00099	0.001	0.00066	0.0009	0.0015	0.001	0.0013	0.0018	0.0011
		(0.7328)	(0.6996)	(0.7350)	***(1.6594)***	***(2.0117)***	***(1.6628)***	***(2.2202)***	***(3.5570)***	***(2.4660)***	***(1.6826)***	***(2.4685)***	***(2.4292)***
	Sell	-0.0001	-1.E-04	-0.0005	-0.0005	-0.0009	-0.0006	-0.0008	-0.0015	-0.0013	-0.0008	-0.0011	-0.0011
		(1.2619)	(0.9403)	(0.8229)	***(1.8652)***	***(2.1002)***	***(2.1486)***	***(2.3750)***	***(4.2178)***	***(2.7852)***	***(1.6996)***	***(2.3845)***	***(3.1792)***
	Buy-Sell	0.0005	0.00036	0.00057	0.0015	0.0019	0.0013	0.0017	0.0030	0.0023	0.0021	0.0029	0.0022
		(1.7388)	(1.4214)	(1.3446)	***(3.0309)***	***(3.5543)***	***(3.3015)***	***(3.9681)***	***(6.7184)***	***(4.5389)***	***(2.9227)***	***(4.1937)***	***(4.8583)***
(1,50,0.01)	N(Buy)	2379	1995	1879	2505	2210	2169	2169	2423	2054	1789	1748	2196
	N(Sell)	1295	1512	2082	1585	1988	1718	1741	1732	2123	1722	1765	1892
	Buy	0.0003	0.0003	0.0006	0.00105	0.001	0.0008	0.001	0.0016	0.0011	0.0014	0.0019	0.0013
		(0.5817)	(0.8930)	(0.6762)	***(1.7463)***	***(1.9260)***	***(1.9572)***	***(2.2622)***	***(3.6234)***	***(2.6065)***	***(1.8313)***	***(2.5489)***	***(2.7954)***
	Sell	-0.0002	-3.E-04	-0.0004	-0.0008	-0.0008	-0.0007	-0.0009	-0.0015	-0.0014	-0.0008	-0.0012	-0.0012
		(1.3300)	(1.3800)	(0.4672)	***(2.2057)***	***(1.8717)***	***(2.2186)***	***(2.7107)***	***(4.1727)***	***(3.0497)***	***(1.6424)***	***(2.3157)***	***(3.4226)***
	Buy-Sell	0.0005	0.00055	0.00046	0.0019	0.0018	0.0015	0.0019	0.0031	0.0025	0.0022	0.0031	0.0025
		(1.6327)	(1.8965)	(0.9667)	***(3.3425)***	***(3.2273)***	***(3.5100)***	***(4.1888)***	***(6.6083)***	***(4.8047)***	***(2.9575)***	***(4.1443)***	***(5.2749)***
(1,150,0)	N(Buy)	3125	2627	2034	2911	2465	2469	2604	2790	2220	2088	1882	2592
	N(Sell)	1421	1919	2512	1635	2081	2077	1942	1756	2326	1653	1859	1954
	Buy	0.0002	0.00012	0.00008	0.0006	0.0007	0.0006	0.0007	0.0009	0.0008	0.0007	0.0013	0.0009

		(0.1272)	(0.1203)	(0.7446)	(0.7533)	(1.3886)	(1.5284)	***(1.6707)***	***(1.8658)***	***(2.0276)***	(0.7741)	***(1.6499)***	***(1.8773)***
	Sell	3E-05	-1.E-05	-0.0005	-0.0003	-0.0006	-0.0005	-0.0006	-0.0006	-0.0007	-0.0003	-0.0008	-0.0007
		(0.6656)	(0.4470)	(0.6815)	(1.3841)	(1.5869)	(1.9945)	***(1.8037)***	***(1.8854)***	***(1.6404)***	(0.8704)	***(1.7171)***	***(2.2856)***
	Buy-Sell	0.0002	0.00013	0.00058	0.0009	0.0013	0.0011	0.0013	0.0015	0.0015	0.001	0.0021	0.0016
		(0.7216)	(0.5008)	(1.2273)	(1.8610)	(2.5639)	(3.0412)	***(2.9844)***	***(3.1953)***	***(3.0080)***	(1.4140)	***(2.8970)***	***(3.5869)***
(1,150,0.01)	N(Buy)	2826	2327	1887	2744	2357	2324	2436	2667	2050	1963	1727	2489
	N(Sell)	1192	1606	2318	1497	1985	1892	1773	1655	2133	1550	1742	1851
	Buy	0.0003	0.00014	0.0002	0.00064	0.0008	0.0007	0.0008	0.001	0.0009	0.0007	0.0014	0.0011
		(0.3236)	(0.1555)	(1.0064)	(0.7801)	(1.4129)	***(1.7788)***	***(1.9105)***	***(2.1070)***	***(2.1976)***	(0.7948)	***(1.7582)***	***(2.3837)***
	Sell	3E-05	0.00001	-0.0004	-0.0004	-0.0008	-0.0006	-0.0006	-0.0006	-0.0008	-0.0003	-0.0009	-0.0007
		(0.7225)	(0.3936)	(0.5198)	(1.3533)	(1.6696)	***(1.7949)***	***(1.7871)***	***(1.7666)***	***(1.6460)***	(0.9037)	***(1.8358)***	***(2.2406)***
	Buy-Sell	0.0003	0.00013	0.0006	0.00104	0.0016	0.0013	0.0014	0.0016	0.0017	0.001	0.0023	0.0018
		(0.9015)	(0.4722)	(1.3102)	(1.8333)	(2.6379)	***(3.0453)***	***(3.1237)***	***(3.2464)***	***(3.2703)***	(1.4463)	***(3.0555)***	***(3.9290)***
(1,200,0)	N(Buy)	3241	2710	2008	2950	2417	2592	2820	2782	2319	2041	1792	2695
	N(Sell)	1255	1786	2488	1546	2079	1904	1676	1714	2177	1650	1899	1801
	Buy	0.0003	0.00015	0.0001	0.00056	0.0007	0.0004	0.0008	0.0009	0.0007	0.0007	0.0014	0.0008
		(0.2815)	(0.2022)	(0.8487)	(0.6067)	(1.3462)	(1.1193)	***(2.0024)***	***(1.8641)***	(1.8232)	(0.8216)	***(1.7125)***	***(1.6830)***
	Sell	-6E-05	-2.E-05	-0.0005	-0.0003	-0.0006	-0.0004	-0.0007	-0.0005	-0.0005	-0.0003	-0.0008	-0.0005
		(0.9664)	(0.5226)	(0.7944)	(1.2214)	(1.4791)	(1.5507)	***(1.9521)***	***(1.6480)***	(0.9691)	(0.8379)	***(1.7294)***	***(1.6675)***
	Buy-Sell	0.0003	0.00017	0.0006	0.00086	0.0013	0.0008	0.0015	0.0014	0.0012	0.001	0.0022	0.0013
		(1.1170)	(0.6368)	(1.4109)	(1.5946)	(2.4292)	(2.3032)	***(3.3475)***	***(2.9585)***	(2.3926)	(1.4217)	***(2.9543)***	***(2.8547)***
(1,200,0.01)	N(Buy)	3015	2464	1884	2862	2326	2413	2589	2694	2112	1941	1704	2581
	N(Sell)	1103	1535	2350	1474	2003	1737	1540	1644	1970	1556	1796	1702
	Buy	0.0003	0.00017	0.0003	0.0006	0.0007	0.0005	0.0009	0.0009	0.0008	0.0007	0.0015	0.0009
		(0.1510)	(0.3246)	(1.1482)	(0.7101)	(1.3838)	(1.2766)	***(2.2300)***	***(1.7355)***	(1.9933)	(0.8368)	***(1.8590)***	***(1.8747)***
	Sell	-0.0002	-8.E-05	-0.0005	-0.0004	-0.0007	-0.0004	-0.001	-0.0006	-0.0006	-0.0004	-0.001	-0.0006

		(1.2679)	(0.7421)	(0.8273)	(1.4552)	(1.5013)	(1.4417)	***(2.5948)***	***(1.8404)***	(1.1578)	(0.8999)	***(2.0133)***	***(1.8661)***
	Buy-Sell	0.0005	0.00025	0.0008	0.001	0.0014	0.0009	0.0019	0.0015	0.0014	0.0011	0.0025	0.0011
		(1.3056)	(0.9193)	(1.6885)	(1.8803)	(2.4652)	(2.3028)	***(4.0639)***	***(3.0253)***	(2.6594)	(1.4765)	***(3.2951)***	***(3.1619)***
(2,200,0)	N(Buy)	3237	2703	2000	2946	2419	2595	2819	2780	2314	2045	1791	2694
	N(Sell)	1259	1793	2496	1550	2077	1901	1677	1716	2182	1646	1900	1802
	Buy	0.0003	0.00013	0.0002	0.00059	0.0007	0.0005	0.0007	0.0009	0.0007	0.0007	0.0013	0.0005
		(0.3210)	(0.1137)	(1.0138)	(0.6946)	(1.2992)	(1.0444)	***(1.7133)***	***(1.8637)***	***(1.8219)***	(0.8057)	(1.5892)	(0.7900)
	Sell	-8E-05	0.00001	-0.0006	-0.0003	-0.0006	-0.0003	-0.0006	-0.0005	-0.0008	-0.0002	-0.0005	-0.0004
		(1.0371)	(0.4048)	(0.9335)	(1.3526)	(1.4288)	(1.4614)	***(1.6416)***	***(1.7316)***	***(1.6589)***	(0.8221)	(1.2433)	(1.5047)
	Buy-Sell	0.0004	0.00012	0.0008	0.00089	0.0013	0.0008	0.0013	0.0014	0.0015	0.0009	0.0018	0.0009
		(1.2117)	(0.4591)	(1.6725)	(1.7829)	(2.3455)	(2.1621)	***(2.8379)***	***(3.0437)***	***(2.9909)***	(1.3945)	(2.4343)	(1.9975)
(2,200,0.01)	N(Buy)	3022	2461	1878	2861	2332	2406	2586	2701	2109	1939	1698	2575
	N(Sell)	1101	1536	2349	1470	2008	1737	1535	1638	1963	1549	1800	1707
	Buy	0.0002	0.00017	0.0002	0.00063	0.0007	0.0005	0.0008	0.0009	0.0007	0.0008	0.0013	0.0005
		(0.0686)	(0.3370)	(1.1161)	(0.7621)	(1.2977)	(1.1650)	***(1.9481)***	***(1.8468)***	***(1.7653)***	(0.9025)	(1.6606)	(0.9261)
	Sell	-0.0001	-1.E-05	-0.0005	-0.00031	-0.0007	-0.0004	-0.0007	-0.0006	-0.0009	-0.0004	-0.0006	-0.0005
		(1.1996)	(0.4227)	(0.9668)	(1.2552)	(1.5211)	(1.4579)	***(1.7910)***	***(1.8379)***	***(1.8205)***	(1.0127)	(1.3086)	(1.5280)
	Buy-Sell	0.0004	0.00018	0.0007	0.00093	0.0014	0.0009	0.0015	0.0015	0.0016	0.0012	0.0019	0.001
		(1.1865)	(0.6400)	(1.7337)	(1.7321)	(2.4120)	(2.2279)	***(3.1147)***	***(3.1081)***	***(3.0355)***	(1.6289)	(2.5303)	(2.1111)
(5,150,0)	N(Buy)	3117	2631	2031	2924	2468	2457	2604	2793	2196	2103	1887	2605
	N(Sell)	1429	1915	2515	1622	2078	2089	1942	1753	2350	1638	1854	1941
	Buy	0.0003	0.00012	0.0001	0.00052	0.0006	0.0006	0.0007	0.0006	0.0004	0.0007	0.001	0.0007
		(0.1867)	(0.0740)	(0.9447)	(0.4969)	(1.1289)	(1.3596)	***(1.6707)***	(1.1059)	(1.0995)	(0.8248)	(1.1205)	(1.2962)
	Sell	1E-05	0.00001	-0.0005	-0.00017	-0.0006	-0.0005	-0.0005	-0.0003	-0.0004	-0.0004	-0.0003	-0.0006
		(0.7621)	(0.3908)	(0.8539)	(1.0163)	(1.2987)	(1.7935)	***(1.6506)***	(1.1781)	(0.6984)	(0.9397)	(0.8553)	(2.0919)
	Buy-Sell	0.0002	0.00011	0.0006	0.00072	0.0012	0.0011	0.0012	0.0009	0.0008	0.0011	0.0013	0.0013

		(0.8557)	(0.4127)	(1.5482)	(1.3234)	(2.0919)	(2.7223)	***(2.8466)***	(1.9493)	(1.5522)	(1.5172)	(1.6992)	(2.9386)
(5,150,0.01)	N(Buy)	2825	2324	1892	2751	2354	2309	2427	2658	2046	1976	1729	2491
	N(Sell)	1175	1599	2325	1479	1974	1895	1765	1647	2127	1546	1723	1855
	Buy	0.0002	0.00015	0.0003	0.00056	0.0006	0.0007	0.0008	0.0007	0.0005	0.0007	0.001	0.0008
		(0.1030)	(0.2247)	(1.1618)	(0.5903)	(1.1023)	(1.6170)	***(1.7705)***	(1.1787)	(1.2976)	(0.7309)	(1.1613)	(1.5877)
	Sell	3E-05	-7.E-05	-0.0005	-0.0003	-0.0007	-0.0004	-0.0006	-0.0004	-0.0004	-0.0004	-0.0006	-0.0006
		(0.6505)	(0.6678)	(0.8075)	(1.2126)	(1.4920)	(1.7602)	***(1.7429)***	(1.4644)	(0.7302)	(1.0024)	(1.3612)	(2.0874)
	Buy-Sell	0.0002	0.00022	0.0008	0.00086	0.0013	0.0011	0.0014	0.0011	0.0009	0.0011	0.0016	0.0014
		(0.6819)	(0.7704)	(1.6831)	(1.5609)	(2.2235)	(2.8713)	***(2.9704)***	(2.2496)	(1.7262)	(1.4822)	(2.1431)	(3.1497)
(5,200,0)	N(Buy)	3243	2701	1996	2946	2422	2579	2813	2781	2308	2053	1803	2694
	N(Sell)	1253	1795	2500	1550	2074	1917	1683	1715	2188	1638	1888	1802
	Buy	0.0003	0.00014	0.0001	0.00061	0.0008	0.0005	0.0005	0.0008	0.0001	0.0005	0.0013	0.0005
		(0.2548)	(0.1485)	(0.8920)	(0.7315)	(1.4323)	(1.0637)	(1.1731)	(1.4651)	(0.4159)	(0.5610)	(1.7001)	(0.7147)
	Sell	-4E-05	-1.E-05	-0.0005	-0.0004	-0.0007	-0.0004	-0.0006	-0.0005	-0.0004	-0.0001	-0.0006	-0.0004
		(0.9179)	(0.4500)	(0.8264)	(1.4088)	(1.5788)	(1.4717)	(1.6179)	(1.6400)	(0.7409)	(0.5432)	(1.3629)	(1.4064)
	Buy-Sell	0.0003	0.00013	0.0006	0.001	0.0015	0.0009	0.0011	0.0013	0.0004	0.0006	0.0019	0.0009
		(1.0523)	(0.5279)	(1.4756)	(1.8631)	(2.5889)	(2.1872)	(2.3990)	(2.6480)	(0.9970)	(0.9448)	(2.6316)	(1.8482)
(5,200,0.01)	N(Buy)	3014	2461	1863	2869	2337	2403	2592	2701	2100	1940	1691	2577
	N(Sell)	1096	1542	2349	1478	2000	1736	1533	1630	1967	1537	1796	1703
	Buy	0.0002	0.00018	0.0003	0.00062	0.0007	0.0004	0.0004	0.0009	0.0002	0.0006	0.0014	0.0006
		(0.1203)	(0.3310)	(1.0389)	(0.7480)	(1.3143)	(1.0997)	(0.9353)	***(1.8468)***	(0.6294)	(0.6362)	(1.7728)	(1.0683)
	Sell	-0.0001	-5.E-05	-0.0005	-0.0004	-0.0007	-0.0003	-0.0008	-0.0006	-0.0004	-0.0003	-0.0005	-0.0005
		(1.1515)	(0.6284)	(0.8892)	(1.3738)	(1.5357)	(1.2266)	(1.9245)	***(1.8345)***	(0.7141)	(0.7165)	(1.1744)	(1.6274)
	Buy-Sell	0.0004	0.00023	0.0008	0.001	0.0014	0.0007	0.0012	0.0015	0.0006	0.0009	0.0019	0.0011
		(1.1747)	(0.8214)	(1.6412)	(1.8333)	(2.4383)	(1.9694)	(2.4673)	***(3.1033)***	(1.1377)	(1.1498)	(2.5215)	(2.3127)

AVERAGE	N (Buy)	2996	2497	1963	2839	2377	2440	2584	2702	2178	1985	1781	2556
	N (Sell)	1276	1719	2394	1561	2048	1890	1742	1716	2154	1632	1829	1847
	Buy	0.0003	0.0002	0.0002	0.0007	0.0008	0.0006	0.0008	0.0010	0.0007	0.0008	0.0014	0.0008
		(0.2584)	(0.2991)	(1.0560)	(0.9429)	(1.4023)	(1.3647)	***(1.8072)***	***(2.0261)***	***(1.7850)***	(0.9367)	**(1.7453)**	***(1.8689)***
	Sell	-0.0001	-5.E-05	-0.0005	-0.0004	-0.0007	-0.0005	-0.0007	-0.0007	-0.0008	-0.0004	-0.0007	-0.0007
		(1.0104)	(0.6282)	(0.7443)	(1.4692)	(1.5864)	(1.6427)	***(1.9798)***	***(2.0615)***	***(1.6515)***	(0.9899)	**(1.6447)**	***(2.0403)***
	Buy-Sell	0.0003	0.0002	0.0007	0.0010	0.0015	0.0010	0.0015	0.0017	0.0015	0.0012	0.0021	0.0015
		(1.1349)	(0.8015)	(1.5459)	(2.0736)	(2.5641)	(2.5718)	***(3.2193)***	***(3.4687)***	***(2.9370)***	(1.6468)	**(2.8749)**	***(3.3410)***

Panel B: VMA rules not adjusted for inflation

		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns		0.0215%	0.0104%	-0.0212%	0.0323%	0.0087%	0.0127%	0.0107%	0.0213%	-0.0077%	0.0237%	0.0273%	0.0202%
Rules													
(1,50,0)	N(Buy)	2913	2557	2204	2795	2418	2567	2554	2650	2310	1937	1917	2488
	N(Sell)	1733	2089	2442	1851	2228	2079	2092	1996	2336	1904	1924	2158
	Buy	0.0004	0.00026	0.00008	0.001	0.0011	0.0007	0.0009	0.0016	0.001	0.0013	0.0019	0.0011
		(0.7331)	(0.6999)	(0.7368)	***(1.6607)***	***(2.1256)***	***(1.7703)***	***(2.1919)***	***(3.5587)***	***(2.4684)***	***(1.6853)***	***(2.6369)***	***(2.4313)***
	Sell	-0.0001	-0.0001	-0.00052	-0.0005	-0.0009	-0.0006	-0.0008	-0.0015	-0.0013	-0.0008	-0.0011	-0.0010
		(1.2610)	(0.9403)	(0.8251)	***(1.8635)***	***(2.0978)***	***(2.1522)***	***(2.3386)***	***(4.2188)***	***(2.7876)***	***(1.6926)***	***(2.2157)***	***(3.1859)***
	Buy-Sell	0.0005	0.00036	0.0006	0.0015	0.0020	0.0013	0.0017	0.0031	0.0023	0.0021	0.003	0.0021
		(1.7382)	(1.4218)	(1.3481)	***(3.0305)***	***(3.6493)***	***(3.3942)***	***(3.9120)***	***(6.7207)***	***(4.5431)***	***(2.9189)***	***(4.1935)***	***(4.8659)***
(1,50,0.01)	N(Buy)	2379	1995	1879	2505	2210	2169	2169	2423	2054	1789	1748	2196
	N(Sell)	1295	1512	2082	1585	1988	1718	1741	1732	2123	1722	1765	1892
	Buy	0.0004	0.0003	0.00006	0.0011	0.0011	0.0008	0.001	0.0017	0.0011	0.0014	0.002	0.0013
		(0.5818)	(0.8934)	(0.6790)	***(1.8436)***	***(2.0625)***	**(1.9606)**	***(2.2654)***	***(3.7606)***	***(2.6084)***	***(1.8336)***	***(2.7121)***	***(2.7374)***
	Sell	-0.0002	-2.E-04	-0.0004	-0.0008	-0.0008	-0.0006	-0.001	-0.0016	-0.0015	-0.0009	-0.0012	-0.0012
		(1.3289)	(1.3807)	(0.4694)	***(2.3146)***	***(1.8696)***	**(2.2223)**	***(2.7163)***	***(4.2720)***	***(3.0525)***	***(1.7940)***	***(2.3090)***	***(3.4296)***

	Buy-Sell	0.0006	0.00054	0.00046	0.00019	0.0019	0.0014	0.002	0.0033	0.0026	0.0023	0.0032	0.0025
		(1.6317)	(1.8975)	(0.9708)	***(3.5161)***	***(3.3394)***	**(3.5160)**	***(4.1962)***	***(6.8060)***	***(4.8088)***	***(3.0895)***	***(4.2778)***	***(5.2332)***
(1,150,0)	N(Buy)	3125	2627	2034	2911	2465	2469	2604	2790	2220	2088	1882	2592
	N(Sell)	1421	1919	2512	1635	2081	2077	1942	1756	2326	1653	1859	1954
	Buy	0.0003	0.00014	0.00009	0.0006	0.0007	0.0006	0.0008	0.001	0.0009	0.0007	0.0013	0.0009
		(0.1266)	(0.1225)	(0.7447)	(0.7552)	(1.3823)	(1.5311)	***(1.9239)***	***(2.0347)***	***(2.2312)***	(0.7758)	***(1.6566)***	***(1.8161)***
	Sell	4E-05	0.00001	-0.00046	-0.0003	-0.0007	-0.0006	-0.0007	-0.0006	-0.0008	-0.0003	-0.0009	-0.0007
		(0.6617)	(0.4485)	(0.6829)	(1.3922)	(1.5836)	(1.9984)	***(2.0845)***	***(1.9734)***	***(1.7231)***	(0.8762)	***(1.8703)***	***(2.2930)***
	Buy-Sell	0.0003	0.00013	0.00055	0.0009	0.0014	0.0012	0.0015	0.0016	0.0017	0.001	0.0022	0.0016
		(0.7175)	(0.5040)	(1.2286)	(1.8699)	(2.5557)	(3.0469)	***(3.4434)***	***(3.4086)***	***(3.4092)***	(1.4206)	***(3.0349)***	***(3.5436)***
(1,150,0.01)	N(Buy)	2826	2327	1887	2744	2357	2324	2436	2667	2050	1963	1727	2489
	N(Sell)	1192	1606	2318	1497	1985	1892	1773	1655	2133	1550	1742	1851
	Buy	0.0003	0.00015	0.0002	0.0006	0.0008	0.0007	0.0009	0.0011	0.0009	0.0007	0.0014	0.0012
		(0.3226)	(0.1577)	(1.0062)	(0.7823)	(1.4062)	***(1.7815)***	***(2.1583)***	***(2.2736)***	***(2.1709)***	(0.7965)	***(1.7647)***	***(2.5888)***
	Sell	1E-05	0.00002	-0.00041	-0.0003	-0.0007	-0.0004	-0.0007	-0.0006	-0.0008	-0.0003	-0.0009	-0.0008
		(0.7181)	(0.3955)	(0.5219)	(1.3613)	(1.6660)	***(1.7990)***	***(2.0176)***	***(1.9309)***	***(1.6732)***	(0.9096)	***(1.8291)***	***(2.4578)***
	Buy-Sell	3E-05	0.00013	0.00061	0.0009	0.0015	0.0011	0.0016	0.0017	0.0017	0.001	0.0023	0.002
		(0.8967)	(0.4756)	(1.3117)	(1.8424)	(2.6292)	***(3.0411)***	***(3.5277)***	***(3.5256)***	***(3.2705)***	(1.4529)	***(3.0553)***	***(4.2888)***
(1,200,0)	N(Buy)	3241	2710	2008	2950	2417	2592	2820	2782	2319	2041	1792	2695
	N(Sell)	1255	1786	2488	1546	2079	1904	1676	1714	2177	1650	1899	1801
	Buy	0.0003	0.00015	0.00013	0.0006	0.0007	0.0005	0.0008	0.0009	0.0007	0.0007	0.0014	0.0009
		(0.2811)	(0.2050)	(0.8480)	(0.6085)	(1.3392)	(1.1221)	***(1.9732)***	***(1.7616)***	(1.7954)	(0.8225)	***(1.7175)***	(1.8389)
	Sell	-1E-05	-1.E-05	-0.00051	-0.0002	-0.0006	-0.0004	-0.0008	-0.0005	-0.0005	-0.0003	-0.0008	-0.0005
		(0.9623)	(0.5244)	(0.7957)	(1.2309)	(1.4757)	(1.5551)	***(2.2184)***	***(1.7260)***	(0.9965)	(0.8443)	***(1.7226)***	(1.5912)
	Buy-Sell	0.0003	0.00016	0.00064	0.0008	0.0013	0.0009	0.0016	0.0014	0.0012	0.001	0.0022	0.0014
		(1.1128)	(0.6405)	(1.4115)	(1.6048)	(2.4203)	(2.3095)	***(3.5706)***	***(2.9588)***	(2.3926)	(1.4282)	***(2.9529)***	(2.9090)

(1,200,0.01)	N(Buy)	3015	2464	1884	2862	2326	2413	2589	2694	2112	1941	1704	2581
	N(Sell)	1103	1535	2350	1474	2003	1737	1540	1644	1970	1556	1796	1702
	Buy	0.0003	0.00018	0.00026	0.0006	0.0008	0.0005	0.0009	0.0009	0.0008	0.0007	0.0015	0.001
		(0.1506)	(0.3271)	(1.1476)	(0.7117)	(1.3768)	(1.2798)	***(2.2016)***	***(1.7049)***	(1.9663)	(0.8380)	***(1.8642)***	***(2.0822)***
	Sell	-0.0002	-8.E-05	-0.00052	-0.0004	-0.0007	-0.0004	-0.0009	-0.0006	-0.0006	-0.0004	-0.0008	-0.0006
		(1.2625)	(0.7446)	(0.8291)	(1.4654)	(1.4976)	(1.4462)	***(2.3840)***	***(1.9262)***	(1.1842)	(0.9067)	***(1.6903)***	***(1.9188)***
	Buy-Sell	0.0004	0.00026	0.00078	0.001	0.0015	0.0009	0.0018	0.0015	0.0014	0.0011	0.0023	0.0016
		(1.3003)	(0.9235)	(1.6895)	(1.8911)	(2.4563)	(2.3094)	***(3.8499)***	***(3.0802)***	(2.6595)	(1.4835)	***(3.0270)***	***(3.3725)***
(2,200,0)	N(Buy)	3237	2703	2000	2946	2419	2595	2819	2780	2314	2045	1791	2694
	N(Sell)	1259	1793	2496	1550	2077	1901	1677	1716	2182	1646	1900	1802
	Buy	0.0003	0.00014	0.00019	0.0006	0.0007	0.0005	0.0007	0.0009	0.0007	0.0007	0.0012	0.0005
		(0.3206)	(0.1165)	(1.0132)	(0.6964)	(1.2922)	(1.0473)	***(1.6841)***	***(1.7612)***	***(1.7941)***	(0.8066)	(1.5942)	(0.7892)
	Sell	-7E-05	2.E-05	-0.0006	-0.0003	-0.0006	-0.0003	-0.0006	-0.0005	-0.0008	-0.0003	-0.0005	-0.0004
		(1.0332)	(0.4065)	(0.9348)	(1.3621)	(1.4255)	(1.4659)	***(1.7350)***	***(1.7268)***	***(1.6863)***	(0.8285)	(1.2529)	(1.5112)
	Buy-Sell	0.0004	0.00012	0.00079	0.0009	0.0013	0.0008	0.0013	0.0014	0.0015	0.001	0.0017	0.0009
		(1.2077)	(0.4628)	(1.6730)	(1.7931)	(2.3368)	(2.1684)	***(2.9014)***	***(2.9594)***	***(2.9910)***	(1.4009)	(2.4468)	(2.0028)
(2,200,0.01)	N(Buy)	3022	2461	1878	2861	2332	2406	2586	2701	2109	1939	1698	2575
	N(Sell)	1101	1536	2349	1470	2008	1737	1535	1638	1963	1549	1800	1707
	Buy	0.0002	0.00018	0.00024	0.0006	0.0007	0.0005	0.0008	0.0009	0.0007	0.0008	0.0013	0.0006
		(0.0683)	(0.3397)	(1.1156)	(0.7635)	(1.2906)	(1.1682)	***(1.9196)***	***(1.7453)***	***(1.7384)***	(0.9034)	(1.6657)	(0.9254)
	Sell	-0.0001	0.00001	-0.00058	-0.0003	-0.0007	-0.0004	-0.0007	-0.0006	-0.0009	-0.0004	-0.0005	-0.0004
		(1.1944)	(0.4251)	(0.9687)	(1.1654)	(1.5175)	(1.4624)	***(1.9128)***	***(1.9236)***	***(1.8469)***	(1.0194)	(1.3189)	(1.5342)
	Buy-Sell	0.0003	0.00017	0.00082	0.0009	0.0014	0.0009	0.0015	0.0015	0.0016	0.0012	0.0018	0.001
		(1.1814)	(0.6442)	(1.7748)	(1.7427)	(2.4029)	(2.2345)	***(3.2043)***	***(3.1083)***	***(3.0356)***	(1.6356)	(2.5433)	(2.1162)

(5,150,0)	N(Buy)	3117	2631	2031	2924	2468	2457	2604	2793	2196	2103	1887	2605
	N(Sell)	1429	1915	2515	1622	2078	2089	1942	1753	2350	1638	1854	1941
	Buy	0.0003	0.00013	0.00016	0.0005	0.0006	0.0005	0.0007	0.0007	0.0004	0.0007	0.001	0.0007
		(0.1861)	(0.0764)	(0.9446)	(0.4994)	(1.1228)	(1.3625)	***(1.6422)***	(1.0870)	(1.0721)	(0.8264)	(1.1242)	(1.2973)
	Sell	6E-05	0.00002	-0.0005	-0.0002	-0.0005	-0.0005	-0.0006	-0.0002	-0.0004	-0.0004	-0.0003	-0.0006
		(0.7583)	(0.3924)	(0.8552)	(1.0254)	(1.2956)	(1.7976)	***(1.8294)***	(1.1513)	(0.6991)	(0.9454)	(0.8625)	(2.0992)
	Buy-Sell	0.0002	0.00011	0.00066	0.0007	0.0011	0.001	0.0013	0.0009	0.0008	0.0011	0.0013	0.0013
		(0.8517)	(0.4161)	(1.5492)	(1.3338)	(2.0841)	(2.7284)	***(2.9843)***	(1.9098)	(1.5289)	(1.5236)	(1.7087)	(2.9460)
(5,150,0.01)	N(Buy)	2825	2324	1892	2751	2354	2309	2427	2658	2046	1976	1729	2491
	N(Sell)	1175	1599	2325	1479	1974	1895	1765	1647	2127	1546	1723	1855
	Buy	0.0003	0.00016	0.00026	0.0006	0.0006	0.0007	0.0008	0.0007	0.0005	0.0007	0.001	0.0008
		(0.1022)	(0.2270)	(1.1616)	(0.5932)	(1.0959)	(1.6198)	***(1.8803)***	(1.1567)	(1.2709)	(0.7324)	(1.1661)	(1.5273)
	Sell	4E-05	-5.E-05	-0.00052	-0.0003	-0.0007	-0.0005	-0.0006	-0.0004	-0.0004	-0.0004	-0.0006	-0.0006
		(0.6463)	(0.6697)	(0.8096)	(1.2212)	(1.4886)	(1.7644)	***(1.7678)***	(1.4372)	(0.7609)	(1.0079)	(1.3546)	(2.0952)
	Buy-Sell	0.0002	0.00021	0.00078	0.0009	0.0013	0.0012	0.0014	0.0011	0.0009	0.0011	0.0016	0.0014
		(0.6774)	(0.7739)	(1.6847)	(1.5710)	(2.2152)	(2.8773)	***(3.0803)***	(2.2077)	(1.7294)	(1.4882)	(2.1415)	(3.1079)
(5,200,0)	N(Buy)	3243	2701	1996	2946	2422	2579	2813	2781	2308	2053	1803	2694
	N(Sell)	1253	1795	2500	1550	2074	1917	1683	1715	2188	1638	1888	1802
	Buy	0.0003	0.00014	0.00015	0.0006	0.0008	0.0005	0.0006	0.0008	0.0001	0.0006	0.0013	0.0005
		(0.2544)	(0.1513)	(0.8915)	(0.7332)	(1.4254)	(1.0664)	(1.3942)	(1.4361)	(0.3881)	(0.5618)	(1.7053)	(0.7137)
	Sell	-3E-05	0.00001	-0.00052	-0.0004	-0.0007	-0.0004	-0.0006	-0.0003	-0.0003	-0.0001	-0.0006	-0.0004
		(0.9139)	(0.4518)	(0.8277)	(1.4181)	(1.5756)	(1.4759)	(1.6154)	(1.1990)	(0.5384)	(0.5494)	(1.3727)	(1.4127)
	Buy-Sell	0.0003	0.00013	0.00067	0.001	0.0015	0.0009	0.0012	0.0011	0.0004	0.0007	0.0019	0.0009
		(1.0483)	(0.5316)	(1.4762)	(1.8730)	(2.5804)	(2.1931)	(2.5679)	(2.2209)	(0.7977)	(0.9509)	(2.6445)	(1.8531)
(5,200,0.01)	N(Buy)	3014	2461	1863	2869	2337	2403	2592	2701	2100	1940	1691	2577
	N(Sell)	1096	1542	2349	1478	2000	1736	1533	1630	1967	1537	1796	1703

	Buy	0.0003	0.00018	0.00021	0.0006	0.0007	0.0004	0.0007	0.0008	0.0002	0.0006	0.0014	0.0006
		(0.1199)	(0.3336)	(1.0380)	(0.7496)	(1.3075)	(1.1029)	(1.6398)	(1.6002)	(0.6024)	(0.6368)	(1.7780)	(1.0073)
	Sell	-0.0001	-5.E-05	-0.00055	-0.0004	-0.0007	-0.0003	-0.0007	-0.0003	-0.0004	-0.0003	-0.0005	-0.0005
		(1.1463)	(0.6309)	(0.8910)	(1.3840)	(1.5322)	(1.2310)	(1.9214)	(1.0947)	(0.7405)	(0.7228)	(1.1846)	(1.6332)
	Buy-Sell	0.0004	0.00023	0.00076	0.001	0.0014	0.0007	0.0014	0.0011	0.0006	0.0009	0.0019	0.0011
		(1.1695)	(0.8257)	(1.6419)	(1.8439)	(2.4296)	(1.9759)	(2.9993)	(2.2354)	(1.1378)	(1.1560)	(2.5256)	(2.2700)
AVERAGE	N (Buy)	2996	2497	1963	2839	2377	2440	2584	2702	2178	1985	1781	2556
	N (Sell)	1276	1719	2394	1561	2048	1890	1742	1716	2154	1632	1829	1847
	Buy	0.0003	0.0002	0.0002	0.0007	0.0008	0.0006	0.0008	0.0010	0.0007	0.0008	0.0014	0.0009
		(0.3285)	(0.2995)	(0.9451)	(0.9193)	(1.4782)	(1.3581)	***(1.9193)***	***(2.0103)***	***(1.6812)***	(0.9436)	**(1.7703)**	***(1.8080)***
	Sell	-0.0001	-4.E-05	-0.0005	-0.0004	-0.0007	-0.0005	-0.0007	-0.0006	-0.0008	-0.0004	-0.0007	-0.0006
		(0.9791)	(0.6108)	(0.7897)	(1.4884)	(1.6149)	(1.6348)	***(2.0045)***	***(2.0528)***	***(1.6787)***	(0.9963)	**(1.6815)**	***(2.0766)***
	Buy-Sell	0.0003	0.0002	0.0007	0.0010	0.0015	0.0010	0.0015	0.0016	0.0015	0.0012	0.0021	0.0015
		(1.1544)	(0.7860)	(1.4856)	(2.0736)	(2.6526)	(2.5593)	***(3.3302)***	***(3.4484)***	***(2.8718)***	(1.6582)	**(2.8680)**	***(3.3228)***

Table 4.2 presents the results of the VMA rules for daily data from 1991-2008. Rules are identified as (short, long, and band). Buy-and-hold results are the average unconditional 1-day return for each of the stock market index. N(Buy) and N(Sell) are the number of buy and sell signals generated during the sample period, respectively. Numbers in parentheses are standard t-statistics using a two-tailed test. T-statistics value is greater than 2.576 indicates statistical significance at 1% level, greater than 1.96 indicates statistical significance at 5% level, and greater than 1.64 indicates statistical significance at 10% level. The Bond and Italic t-test values in the parentheses indicate the statistical significance at 1%, 5%, or 10% levels.

4.4. Results of the fixed-length moving average rules (FMA)

The second moving average trading rule is the fixed-length moving average rule (FMA), which examines a fixed 10-day holding period after a crossover of the two moving averages. The buy and sell signals are identified by observing the crossover points of the short-run and long-run moving averages, and the returns computed by cumulating the price changes over a 10-day holding period after a signal is generated. Similar to the VMA trading rules, for the FMA trading rules to be effective, the average buy returns must be positive and the average sell returns must be negative, and are statistically significantly different from the buy-and-hold returns. The data in Table 4.3 shows the results for the fixed-length moving average (FMA) rules with holding period of 10 days and the mean 10-day buy-and-hold returns for each stock market. In the previous examination of the VMA rules, we observe that the daily inflation adjusted return is similar to the raw daily return (not adjusted for inflation) computed after generating a signal. Therefore, this study only presents daily inflation adjusted returns for the remaining FMA and TRB trading rules. Similar to the VMA rules, we use bands of 0%, 0.5%, 1%, and 3%, generating a total of 24 FMA rules. Our results show that the FMA trading rules with band of 0.5% generate similar number of signals as a band of 1% rule and the returns generated by the FMA rules with band of 0.5% are similar to the returns generated by the FMA rules with band of 1%. The FMA trading rules with band of 3% generate much smaller number of signals than bands of 0.5% and 1% rules, especially the rules with large long-run moving average period, such as 200 days. For example, the number of buy (sell) signals generated by the (5,200,0.03) rule for Singapore stock market is 8 (10) for the whole sample period. This implies that a 3% band is too high and filters out many buy and sell signals which may have been useful. These results show that a one percent

band is the most appropriate band to filter out the false signals generated by the technical trading rules. We only present the daily inflation adjusted returns for the FMA rules with 0% and 1% bands across 12 stock market indices, generating a total of 12 FMA rules for each market index. The results for the other FMA rules with bands of 0.5% and 3% are documented in the Appendix 2.

Table 4.3 shows that out of the 144 FMA rules tested for all the markets (12 market indices with 12 FMA rules each), 51 rules (or 35% of the FMA rules) have positive buy returns and negative sell returns, and are significantly different from the unconditional 10-day buy-and-hold returns. For the developed stock markets, 16 rules (or 22% of the FMA rules) out of 72 (6 markets indices with 12 FMA rules each) are significant. Korea stock market has the most number of significant rules in the developed stock markets. The average 10-day buy (sell) returns across 12 FMA rules is 2.38% (-1.30%), compared to the average 10-day buy-and-hold return of 0.2619%, which strongly supports Hypothesis 1 that the buy signals earn positive returns and the sell signals earn negative returns, and are statistically significantly different from the buy-and-hold returns. Thus, it offers predictive ability for the Korean stock market. Australia, New Zealand, and Singapore stock markets each have only one significant rule and Hong Kong stock market has two significant rules. All the FMA rules in Table 4.3 are insignificant for the Japanese stock market. Our results are consistent with Lento (2007) for the Australian stock market; and Bessembinder and Chan (1995) for the Hong Kong and Japanese stock markets. The authors found that the FMA rules perform worse in these developed stock markets.

For the emerging stock markets, 35 rules (or 49% of the FMA rules) out of 72 (6 markets indices with 12 FMA rules each) are significant. The FMA results support the same conclusions as those obtained from the VMA rules in Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets. These four stock markets have the most number of significant FMA rules. The average 10-day buy (sell) returns across the 12 FMA rules are: 0.84% (-0.55%) for Malaysia, 0.80% (-1.08%) for Indonesia, 0.57% (-0.66%) for Thailand, 0.84% (-0.7%) for Shenzhen, and 1.87% (-0.54%) for the Philippines stock markets. These returns are higher than their average 10-day buy-and-hold returns of 0.2057%, 0.298%, 0.07%, 0.4732%, and 0.2567% for Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets, respectively. Similar to the VMA rules, all the significant FMA rules in the two Chinese stock markets come from the short term variant of the technical trading rules. For example, the significant FMA rules for the Shanghai stock markets are (1,50,0) and (1,50,0.01). When a 1-day lag returns are implemented to adjust for non-synchronous trading, the average buy and sell returns are quite similar to Bessembinder and Chan (1995) and Ratner and Leal (1999) results for Malaysia, Thailand and the Philippines stock markets; Lento (2007) for the Jakarta (Indonesia) and KOSPI (Korea) stock market indices; and Balsara et al. (2007) for the Shenzhen stock market. These results show that the FMA trading rules have predictive ability to forecast price changes.

The results in Table 4.3 show that the number of buy and sell signals generated by the FMA trading rules is far fewer than the VMA trading rules. The FMA rules generate a smaller number of signals because the position must be held for a fixed number of days (usually 10 days holding period). Any signals appearing during the 10-day

holding period are ignored. For example, consider a buy signal that appears five days after a sell signal is generated. Under the VMA rule, the investor would respond to the second signal; under the FMA rule with a holding period longer than one day the investor would not react. In addition, the FMA rules earn returns, on average, similar to their VMA counterparts. For example, the average 10-day buy-sell differences for Malaysia stock market index with the FMA rules of 1.40% (or 0.14% in daily) is slightly lower than the average daily buy-sell returns of 0.15% generated by the VMA rules. Prior researches also found the FMA trading returns are slightly lower than the VMA trading returns (Bessembinder and Chan, 1995; Lam et al., 2007). The result of the FMA trading rules is as expected. Different from the VMA rules, when a buy or sell signal is generated by the FMA rules, the 10-day holding period returns are collected. All signals that appear inside the ten holding days are ignored. The accuracy of the FMA rules should be smaller than the VMA rules. The returns of the FMA rules are slightly lower than those of the VMA rules, it seems that the information within the first nine trading days of the signal is still valuable to investors (Lam et al., 2007).

Overall, the results indicate that the FMA trading rules have predictive power to forecast price movements in the Asia-Pacific stock market. The FMA rules can beat the buy-and-hold strategy to earn excess returns without transaction costs for Korea, Malaysia, Indonesia, Thailand, Shenzhen, and the Philippines stock markets. Majority of the FMA trading rules are insignificant in the developed stock markets of Australia, New Zealand, Japan, Hong Kong, and Singapore. This implies that these developed stock markets support the weak-form EMH and investors can not profit from the FMA trading rules.

Table 4.3 Standard test results for the fixed-length moving average (FMA) rules

FMA rules adjusted for inflation													
		Developed Stock Markets						Emerging Stock Markets					
		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns (%)		0.2263%	0.0986%	-0.24%	0.362%	0.2619%	0.1639%	0.2057%	0.298%	0.07%	0.4577%	0.4732%	0.2567%
Rules													
(1,50,0)	N(Buy)	51	58	66	48	54	57	47	40	49	37	38	51
	N(Sell)	59	68	63	63	60	55	54	44	57	42	45	55
	Buy	0.0003	-0.0019	-0.0017	-2E-05	0.0089	0.0015	0.0055	0.0199	0.009	0.0202	0.0145	0.0042
		(0.0540)	(1.7779)	(0.8078)	(0.1289)	***(3.4231)***	(0.7854)	(2.5244)	***(8.0493)***	***(3.7633)***	***(5.5530)***	***(3.9482)***	***(1.8700)***
	Sell	-0.00102	0.0012	0.0026	0.0019	-0.0048	-0.0024	0.0021	-0.0176	-0.0088	-0.0056	-0.0056	-0.0074
		(1.0490)	(1.0172)	(1.4838)	(0.7521)	***(2.0007)***	(1.4301)	(0.9923)	***(7.6172)***	***(3.9032)***	***(1.7252)***	***(1.7671)***	***(3.7038)***
	Buy-Sell	0.0013	-0.0031	-0.0043	-0.0019	0.0137	0.0039	0.0034	0.0375	0.0178	0.0258	0.0201	0.0116
		(0.7585)	(2.0092)	(1.6369)	(0.5954)	***(3.8833)***	(1.5799)	(1.1743)	***(11.1322)***	***(5.4438)***	***(5.2552)***	***(4.1238)***	***(3.9383)***
(1,50,0.01)	N(Buy)	34	45	52	38	44	39	34	34	43	35	35	42
	N(Sell)	42	42	46	46	45	41	37	38	42	36	36	41
	Buy	0.0016	-0.0012	0.003	0.0037	0.011	0.0026	-0.00088	0.0231	0.0051	0.0155	0.0208	0.0061
		(0.9118)	(1.0440)	(1.5564)	(1.2270)	***(3.8268)***	(1.1634)	(0.3957)	***(8.6431)***	***(2.0218)***	***(4.1204)***	***(5.4509)***	***(2.4940)***
	Sell	-0.0018	-0.0074	-0.0029	0.0001	-0.0106	-0.0022	-0.00111	-0.0157	-0.0158	-0.006	-0.0061	-0.0077
		(1.4746)	(5.6231)	(1.1980)	(0.0892)	***(3.8104)***	(1.1157)	(0.5062)	***(6.3245)***	***(6.0423)***	***(1.7080)***	***(1.7171)***	***(3.3160)***
	Buy-Sell	0.0034	0.0062	0.0059	0.0036	0.0216	0.0048	0.0002	0.0388	0.0209	0.0215	0.0269	0.0138
		(1.6710)	(3.3333)	(1.9491)	(0.9719)	***(5.4257)***	(1.6187)	(0.0650)	***(10.6662)***	***(5.7445)***	***(4.1519)***	***(5.1099)***	***(4.1298)***
(1,150,0)	N(Buy)	29	34	32	27	23	30	29	23	36	21	27	22
	N(Sell)	39	32	27	33	27	24	25	29	35	30	28	29
	Buy	0.0034	-0.0028	-0.0053	0.0018	0.007	0.0013	0.0047	0.0065	0.0059	-0.0055	0.02	0.017
		(1.9080)	(1.9713)	(1.9158)	(0.4363)	***(1.7676)***	(0.4879)	***(1.7001)***	***(1.9518)***	***(2.1188)***	(1.1952)	***(4.6169)***	(5.1764)
	Sell	0.0004	-0.0026	0.0012	-0.0026	-0.0163	-0.0007	-0.0057	-0.0110	-0.0059	0.0141	-0.0102	-0.0014

		(0.1074)	(1.7467)	(0.4970)	(1.0049)	***(4.5131)***	(0.2970)	***(2.0053)***	***(3.9127)***	***(2.0321)***	(3.4692)	***(2.4955)***	(0.5604)
	Buy-Sell	0.003	-0.0002	-0.0065	0.0044	0.0233	0.002	0.0104	0.0175	0.0118	-0.0196	0.0302	0.0184
		(1.3790)	(0.1197)	(1.6674)	(1.0009)	***(4.3718)***	(0.5482)	***(2.6338)***	***(4.0714)***	***(2.9456)***	(3.1539)	***(5.0614)***	(4.2817)
(1,150,0.01)	N(Buy)	19	21	23	19	18	20	20	19	25	17	20	19
	N(Sell)	22	23	21	24	20	20	21	25	31	20	24	20
	Buy	0.0035	-0.0008	-0.0006	0.0027	0.015	0.0056	0.0093	0.007	0.0077	0.0031	0.0236	0.0169
		(1.5917)	(0.5038)	(0.1170)	(0.6067)	***(3.3688)***	***(1.8762)***	***(2.8168)***	***(1.9159)***	***(2.3157)***	(0.5336)	***(4.7019)***	***(4.7838)***
	Sell	0.0026	-0.0036	-0.0129	0.0015	-0.0091	-0.0048	-0.0060	-0.0083	-0.0061	0.0078	-0.0107	-0.0155
		(1.2221)	(2.0690)	(3.8901)	(0.3440)	***(2.1784)***	***(1.6883)***	***(1.9220)***	***(2.7527)***	***(1.9885)***	(1.5531)	***(2.4176)***	***(4.5994)***
	Buy-Sell	0.0009	0.0028	0.0123	0.0012	0.0241	0.0104	0.0153	0.0153	0.0138	-0.0047	0.0343	0.0324
		(0.3344)	(1.0679)	(2.7378)	(0.2249)	***(3.9512)***	***(2.5259)***	***(3.3655)***	***(3.2526)***	***(3.0605)***	(0.6623)	***(5.1165)***	***(6.6498)***
(1,200,0)	N(Buy)	22	33	28	21	16	28	18	21	35	18	21	22
	N(Sell)	28	31	21	23	21	23	26	24	38	24	16	27
	Buy	0.0054	-0.0026	0.0002	-0.0058	0.0369	0.0014	0.0102	0.0061	-0.0009	-0.0038	-0.0022	0.0213
		(2.6828)	(1.8228)	(0.1398)	(1.6738)	***(7.8401)***	(0.5112)	***(2.9387)***	***(1.7468)***	(0.2883)	(0.7894)	(0.5181)	(6.4945)
	Sell	0.0005	-0.0094	-0.0139	-0.0142	-0.0168	-0.0002	-0.0088	-0.0051	-0.0046	-0.005	-0.0135	-0.0007
		(0.1677)	(6.0931)	(4.1725)	(4.1157)	***(4.1085)***	(0.1240)	***(3.1174)***	***(1.6846)***	(1.6638)	(1.1775)	(2.4705)	(0.3077)
	Buy-Sell	0.0049	0.0068	0.0141	0.0083	0.0537	0.0016	0.0190	0.0112	0.0037	0.0012	0.0113	0.022
		(1.9007)	(3.1166)	(3.2529)	(1.6374)	***(8.6243)***	(0.4365)	***(4.2628)***	***(2.4322)***	(0.9479)	(0.1751)	(1.5234)	(5.0390)
(1,200,0.01)	N(Buy)	13	20	20	13	14	19	14	17	28	16	18	13
	N(Sell)	17	19	18	16	20	23	18	20	32	16	13	18
	Buy	0.0087	0.0035	0.004	0.0079	0.0377	0.0023	0.0093	0.0068	-0.0016	-0.0012	0.0041	0.0185
		(3.4246)	***(1.7640)***	(1.2631)	(1.6197)	***(7.4934)***	(0.7215)	***(2.3645)***	***(1.7592)***	(0.4707)	(0.2673)	(0.7286)	(4.3281)
	Sell	0.008	-0.0069	-0.0036	-0.0056	-0.0126	-0.0003	-0.0108	-0.0062	-0.0061	-0.0053	-0.0052	-0.0012
		(3.5841)	***(3.5481)***	(0.9536)	(1.4047)	***(3.0245)***	(0.1581)	***(3.1790)***	***(1.8570)***	(2.0040)	(1.0116)	(0.8929)	(0.3908)
	Buy-Sell	0.0007	0.0104	0.0076	0.0135	0.0503	0.0026	0.0201	0.013	0.0045	0.0041	0.0093	0.0197
		(0.2179)	***(3.7798)***	(1.5643)	(2.1484)	***(7.7007)***	(0.6416)	***(4.2628)***	***(2.5572)***	(1.0289)	(0.5274)	(1.1544)	(3.5562)
(2,200,0)	N(Buy)	19	27	25	17	16	27	18	20	35	17	20	20

	N(Sell)	27	29	20	19	20	23	24	23	37	22	18	24
	Buy	0.0034	-0.0014	-0.0029	0.0079	0.0343	0.0009	0.0117	0.003	-0.0015	-0.0064	-0.0028	0.0167
		(1.5302)	(0.8947)	(0.8935)	***(1.8419)***	***(7.2841)***	(0.3044)	(3.3897)	(0.7916)	(0.5074)	(1.2585)	(0.6156)	(4.8331)
	Sell	0.0068	-0.0085	-0.0059	-0.0227	-0.0164	-0.0018	0.0053	-0.0145	-0.0071	-0.0054	-0.0264	0.0026
		(3.7892)	(5.3651)	(1.6974)	***(5.9386)***	***(3.9192)***	(0.7072)	(1.7305)	(4.5812)	(2.5242)	(1.2170)	(5.0852)	(0.7576)
	Buy-Sell	-0.0034	0.0071	0.003	0.0305	0.0507	0.0027	0.0064	0.0175	0.0056	-0.001	0.0236	0.0141
		(1.2676)	(3.0911)	(0.6706)	***(5.4297)***	***(8.0568)***	(0.7280)	(1.4315)	(3.7122)	(1.4018)	(0.1415)	(3.2729)	(3.0648)
(2,200,0.01)	N(Buy)	13	20	19	12	14	18	14	16	27	16	17	13
	N(Sell)	16	18	16	14	19	21	18	18	30	14	12	17
	Buy	0.0072	-0.0002	-0.0048	0.0014	0.0351	0.0011	0.0070	-0.0015	-0.0005	-0.0088	0.00004	0.0231
		(2.8222)	(0.1774)	(1.3365)	(0.2285)	***(6.9797)***	(0.3136)	(1.7753)	(0.4509)	(0.1295)	(1.6452)	(0.0435)	(5.4175)
	Sell	0.0007	-0.0088	-0.0049	-0.0288	-0.0169	-0.0014	-0.0013	-0.0151	-0.0026	-0.0056	-0.0079	0.0018
		(0.2270)	(4.3644)	(1.2496)	(6.4661)	***(3.9500)***	(0.5513)	(0.4219)	(4.2213)	(0.8051)	(0.9911)	(1.2810)	(0.4326)
	Buy-Sell	0.0065	0.0086	0.0001	0.0302	0.052	0.0025	0.0083	0.0136	0.0021	-0.0032	0.008	0.0213
		(1.9470)	(3.0499)	(0.0168)	(4.5673)	***(7.8820)***	(0.6059)	(1.6130)	(2.5727)	(0.4643)	(0.4011)	(0.9543)	(3.7982)
(5,150,0)	N(Buy)	24	25	22	21	19	22	23	20	29	18	24	18
	N(Sell)	29	27	23	23	20	21	22	25	31	18	22	23
	Buy	0.0031	-0.0026	0.0058	-0.0002	0.0158	0.0072	0.0074	0.0048	0.0102	-0.0067	0.0091	0.0272
		(1.5988)	(1.5643)	(1.8716)	(0.1464)	***(3.6420)***	(2.5347)	***(2.33910)***	(1.3052)	***(3.2838)***	(1.3492)	(1.9365)	***(7.5210)***
	Sell	0.003	-0.004	-0.0093	-0.019	-0.018	-0.0012	-0.0104	-0.0022	-0.0053	-0.0038	0.0014	-0.0052
		(1.6518)	(2.4912)	(2.9199)	(5.4899)	***(4.2962)***	(0.4829)	***(3.3766)***	(0.7995)	***(1.7243)***	(0.7846)	(0.2283)	***(1.7011)***
	Buy-Sell	0.0001	0.0014	0.0151	0.0188	0.0338	0.0084	0.0178	0.007	0.0155	-0.0029	0.0077	0.0324
		(0.0707)	(0.6022)	(3.3878)	(3.6959)	***(5.6184)***	(2.1217)	***(4.0955)***	(1.5093)	***(3.5705)***	(0.4001)	(1.1779)	***(6.7738)***
(5,150,0.01)	N(Buy)	16	20	18	17	14	15	19	16	19	14	17	17
	N(Sell)	18	20	18	16	16	17	19	19	26	15	17	19
	Buy	-0.003	-0.0012	0.0053	-0.0032	0.0144	0.0111	0.0152	0.0226	0.0172	-0.0116	0.0137	0.0207
		(1.3393)	(0.6725)	(1.5517)	(0.8549)	***(2.8472)***	(3.2438)	***(4.5076)***	(5.7846)	***(4.4725)***	(2.0255)	(2.4873)	***(5.5602)***
	Sell	0.0046	-0.0036	-0.0175	-0.0054	-0.0147	0.008	-0.0168	-0.0026	-0.006	-0.0133	0.0179	-0.0103
		(2.0756)	(1.9206)	(4.9045)	(1.3695)	***(3.1486)***	(2.4826)	***(2.0623)***	(0.7976)	***(1.7918)***	(2.3984)	(3.2652)	***(2.9985)***

	Buy-Sell	-0.0074	0.0024	0.0228	0.0022	0.0291	0.0031	0.0320	0.0252	0.0232	0.0017	-0.0042	0.031
		(2.4028)	(0.8844)	(4.5739)	(0.3883)	***(4.2370)***	(0.6653)	***(6.7806)***	(4.8096)	***(4.5740)***	(0.2103)	(0.5513)	***(6.1114)***
(5,200,0)	N(Buy)	17	23	20	14	15	27	18	17	31	17	19	19
	N(Sell)	22	26	21	14	19	20	19	16	33	17	13	19
	Buy	0.0048	0.0014	0.0032	-0.0011	0.035	0.0003	0.0099	-0.0044	0.0053	-0.0159	0.0008	0.0229
		(2.1021)	(0.7316)	(1.0040)	(0.3175)	***(7.1980)***	(0.0666)	***(2.8585)***	(1.2449)	***(1.7920)***	(3.0480)	(0.1050)	***(6.4958)***
	Sell	0.0001	-0.0073	-0.0043	-0.0247	-0.0121	-0.0016	-0.0055	-0.0222	-0.0049	-0.0084	-0.0141	-0.013
		(0.0671)	(4.3896)	(1.2477)	(5.5457)	***(2.8177)***	(0.5997)	***(1.6788)***	(0.1756)	***(1.6425)***	(1.6209)	(2.3302)	***(3.7872)***
	Buy-Sell	0.0047	0.0087	0.0075	0.0236	0.0471	0.0019	0.0154	0.0178	0.0103	-0.0076	0.0149	0.0359
		(1.6261)	(3.5499)	(1.5934)	(3.7024)	***(7.2647)***	(0.4991)	***(3.2257)***	(3.3209)	***(2.4382)***	(1.0113)	(1.8656)	***(7.2859)***
(5,200,0.01)	N(Buy)	12	18	16	11	14	16	12	14	22	14	17	11
	N(Sell)	16	17	13	9	15	17	16	16	29	13	10	17
	Buy	0.0069	-0.0029	-0.0064	0.0128	0.0345	0.001	0.0121	0.0021	0.013	-0.0236	-0.0013	0.0298
		(2.5823)	(1.4509)	(1.6591)	***(2.4550)***	(6.8543)	(0.2652)	***(2.8542)***	(0.4540)	***(3.6506)***	(4.0810)	(0.2906)	***(6.4508)***
	Sell	-0.0044	-0.0087	0.001	-0.0388	-0.0073	-0.0017	-0.0074	-0.0091	-0.0064	-0.0093	-0.0034	-0.0066
		(2.0585)	(4.2059)	(0.3012)	***(6.9715)***	(1.5225)	(0.5769)	***(2.0678)***	(2.4350)	***(2.0320)***	(1.5780)	(0.5195)	***(1.8427)***
	Buy-Sell	0.0113	0.0058	-0.0074	0.0516	0.0418	0.0027	0.0195	0.0112	0.0194	-0.0143	0.0021	0.0364
		(3.3045)	(2.0085)	(1.3367)	***(6.8239)***	(5.9965)	(0.5930)	***(3.5162)***	(1.9983)	***(4.0980)***	(1.6986)	(0.2355)	***(6.1893)***
AVERAGE	N(BUY)	22	29	28	22	22	27	22	21	32	20	23	22
	N(SELL)	28	29	26	25	25	25	25	25	35	22	21	26
	BUY	0.0038	-0.0011	-0.00001	0.0023	0.0238	0.0030	0.0084	0.0080	0.0057	-0.0037	0.0084	0.0187
		(1.8763)	(0.7196)	(0.0713)	(0.5472)	***(5.8823)***	(1.1362)	***(2.6966)***	***(2.3344)***	***(1.9394)***	(0.8103)	**(1.7353)**	***(5.7296)***
	SELL	0.0016	-0.0058	-0.0059	-0.0152	-0.0130	-0.0009	-0.0055	-0.0108	-0.0066	-0.0038	-0.0070	-0.0054
		(0.8280)	(3.6958)	(1.9072)	(4.5856)	***(3.4823)***	(0.3810)	***(1.9213)***	***(3.5439)***	***(2.3018)***	(0.8742)	**(1.6519)**	***(1.8660)***
	BUY-SELL	0.0022	0.0047	0.0059	0.0175	0.0368	0.0039	0.0140	0.0188	0.0124	0.0001	0.0153	0.0241
		(0.8465)	(2.0931)	(1.4365)	(3.5285)	***(6.6955)***	(1.0701)	***(3.2881)***	***(4.1332)***	***(2.0018)***	(0.0136)	**(2.2922)**	***(5.4804)***

Table 4.3 presents the results of FMA rules for daily data from 1991-2008. Cumulative returns are reported for 10-day holding period after signals are detected. Rules are identified by (short, long, band). Buy-and-hold returns are the mean unconditional 10-day returns for each of the stock market index.

N(Buy) and N(Sell) are the number of buy and sell signals generated during the sample period. Numbers in parentheses are standard t-statistics using a two-tailed test. T-statistics value is greater than 2.576 indicates statistical significance at 1% level, greater than1.96 indicates statistical significance at 5% level, and greater than 1.64 indicates statistical significance at 10% level. The Bond and Italic t-test values in the parentheses indicate the statistical significance at 1%, 5%, or 10% levels.

4.5. Results of the trading range breakout rules (TRB)

Table 4.4 show the results for the trading range breakout rules (TRB). According to the TRB rules, the buy (sell) signals are generated when the price level rises above (falls below) the local maxima (local minima). Local maxima and minima are computed over the previous 50, 150, and 200 days. Similar to the FMA rule, we compute a 10-day holding period returns following buy and sell signals for the TRB rule. All signals that appear in the 10-day holding period are ignored. In addition, we introduce a trading band to filter out small fluctuations in the series share price data and avoid generating false signals when the short-run and long-run moving averages are close to each other. We use a band technique where the price level must exceed the local maximum by a certain percentage. In this study, we examine the TRB rules with bands of 0%, 0.5%, 1%, and 3%, generating a total of 24 TRB rules. Similar to the VMA and FMA rules, we find that one percent band is the most appropriate band to filter out false signals generated by the technical trading rules. However, different from the VMA and FMA rules, we find the TRB rules with band of 0.5% generate similar number of signals as rules without a band for most stock markets tested in our study. The returns generated by the TRB rules with band of 0.5% are similar to the returns generated by the TRB rules without a band. The returns generated by the TRB rules with 1% band are higher than rules with bands of 0% and 0.5%. For example, for the Korean stock markets, the mean 10-day returns generated by the (1,50,0) and (1,50,0.005) rules are 0.89% and 0.88%, and the mean 10-day return of 1.18% generated by the (1,50,0.01) rule is higher than the mean 10-day returns generated by the (1,50,0) and (1,50,0.005) rules. In addition, the TRB rules with band of 3% can generate few signals for most of the twelve Asia-Pacific stock markets. For example, implementing the TRB rules with a 3% band can not generate any signals for the

Australian stock markets. Therefore, we only present the daily inflation adjusted returns for the TRB rules with 0% and 1% bands across 12 stock market indices, generating a total of 12 TRB rules for each stock market index. The results of the other TRB rules with bands of 0.5% and 3% are documented in the Appendix 3.

Similar to the VMA and FMA trading rules, for the TRB trading rules to be effective, the average 10-day buy returns must be positive and the average 10-day sell returns must be negative, and are statistically significantly different from the average 10-day buy-and-hold returns. Table 4.4 shows the TRB trading rules generate more buy and sell signals than the fixed-length moving average (FMA) rules. Out of the 72 TRB rules tested for all the stock markets (12 stock market indices with 6 TRB rules each), 32 rules (or 44% of TRB rules) have positive buy and negative sell returns, and are statistically significantly different from the buy-and-hold returns. For the developed stock markets, 8 rules (or 22% of the TRB rules) out of 36 (6 stock market indices with 6 TRB rules each) are significant. Singapore stock market generates the largest potential profits across six TRB trading rules in the developed stock markets. The average 10-day buy (sell) returns earned across six TRB rules are 0.44% (-0.96%). This compares with the unconditional mean 10-day return of 0.1639%. The result clearly shows that for the Singapore stock market, the returns earned from the TRB rules are not equal to those from a simple buy-and-hold strategy. The Hong Kong and Korea stock markets each have two significant rules, namely (1,50,0) and (1,50,0.01). New Zealand stock market has only one significant rule, namely (1,50,0). The Australian and Japanese stock markets did not profit from any of the TRB trading rules.

For the emerging stock markets, 24 rules (or 67% of the TRB rules) out of 36 (6 stock market indices with 6 TRB rules each) are significant. This result indicates that the TRB rules have greater predictive ability for the emerging stock markets than for the developed stock markets. Malaysia, Indonesia, Thailand, and the Philippines stock markets show the most significant trading rules. For the two Chinese stock markets, the Shanghai and Shenzhen index each have two significant rules.

The bottom of Table 4.4 shows the average figures across all 6 TRB trading rules for each stock market. The average 10-day buy (sell) returns for Malaysia, Indonesia, Thailand, and the Philippines stock market indices are statistically significantly different from their average 10-day buy-and-hold returns. The average 10-day buy (sell) returns across six TRB rules are 0.88% (-0.35) for Malaysia, 1.48% (-1.66%) for Indonesia, 1.41% (-0.62%) for Thailand, and 0.83% (-0.48%) for the Philippines stock markets. This compares with their average 10-day buy-and-hold returns of 0.2057%, 0.298%, 0.07%, and 0.2567% for Malaysia, Indonesia, Thailand, and the Philippines stock markets, respectively. The results support Hypothesis 1 that the buy returns are positive and sell returns are negative, and are statistically significantly different from the buy-and-hold returns. This implies that these TRB trading rules offer some predictive ability in the four emerging Asia-Pacific stock markets. Our results are consistent with Bessembinder and Chan (1995) for Malaysia and Thailand stock markets, the authors indicated that the TRB trading rules have predictive ability for the two stock markets; and Lento (2007) for Indonesia and Singapore stock markets.

We find the two TRB rules of (1,50,0) and (1,50,0.01) generate returns that are significantly larger than the simple buy-and-hold returns for Hong Kong, Korea, Shanghai, and Shenzhen stock markets. This indicates that the short periods are useful in detecting the predictive ability of technical trading rules for these stock markets. Our results are consistent with Lam et al. (2007) for the Hong Kong stock market, where the authors showed that only (1,50) trading rules outperform the market and generate profits. Cai et al. (2005) suggested that the technical trading rules have short term predictive ability in the Chinese stock markets. Lento (2007) also reported that the technical trading rules based on short term momentum perform better than long term momentum. We find that the Australian and Japanese stock markets did not profit from any of the TRB trading rules. Lento (2007) also found there is no evidence of profitability for the Japanese and Australian stock markets.

The returns generated by the TRB rules are slightly higher than the VMA and FMA returns for the emerging stock markets. This implies that the TRB trading rules have a greater predictive degree than the moving average based rules. For example, for the Indonesia stock market index, the average TRB 10-day buy-sell return is 3.14% (or 0.314% in daily), compared to the VMA average daily buy-sell return of 0.17% and the FMA average 10-day buy-sell return of 1.88% (or 0.19% in daily). This shows that the TRB rules generate higher average daily returns than both the VMA and FMA rules. Bessembinder and Chan's (1995) study also showed that the TRB trading rules have greater ability to forecast subsequent index price changes than both the VMA and FMA trading rules.

In summary, our results show that the TRB trading rules have the predictive ability in Asia-Pacific stock markets. The TRB rules have stronger predictive ability and can beat the simple buy-and-hold strategy to earn excess returns without transaction costs for Singapore, Malaysia, Indonesia, Thailand, and the Philippines stock markets. The TRB rules performed worse in the developed stock markets of Australia, New Zealand, Japan, Hong Kong, and Korea. Therefore, these developed stock market support the weak-form EMH and investors can not profits from the TRB trading rules.

Table 4.4 Standard test results for the trading range breakout (TRB) rules

TRB rules not adjusted for inflation													
		Developed Stock Markets						Emerging Stock Markets					
		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns (%)		0.2263%	0.0986%	-0.24%	0.362%	0.2619%	0.1639%	0.2057%	0.298%	0.07%	0.4577%	0.4732%	0.2567%
Rules													
(1,50,0)	N(Buy)	156	116	108	138	130	129	126	134	107	101	102	104
	N(Sell)	69	81	108	77	97	80	79	81	92	91	99	85
	Buy	0.0018	0.0024	-0.0015	0.0057	0.004	0.0041	0.0099	0.015	0.0126	0.0158	0.009	0.0145
		(2.1153)	***(2.8338)***	(0.8956)	***(3.7151)***	***(2.3504)***	***(3.3928)***	***(7.4721)***	***(10.9392)***	***(7.6871)***	***(7.0583)***	***(3.9325)***	***(9.4716)***
	Sell	0.0009	-0.0021	0.002	-0.0053	-0.0049	-0.012	-0.0043	-0.0184	-0.0041	-0.0063	-0.0044	-0.0065
		(0.6265)	***(2.2638)***	(1.5001)	***(2.9067)***	***(2.5925)***	***(8.2200)***	***(2.6857)***	***(10.7737)***	***(2.2478)***	***(2.8473)***	***(2.0713)***	***(4.0298)***
	Buy-Sell	0.0009	0.0045	-0.0035	0.011	0.0089	0.0161	0.0142	0.0334	0.0167	0.0221	0.0134	0.021
		(0.6652)	***(3.5914)***	(1.7133)	***(4.6035)***	***(3.5396)***	***(8.6405)***	***(6.8235)***	***(15.3881)***	***(6.9502)***	***(7.0110)***	***(4.2900)***	***(9.4380)***
(1,50,0.01)	N(Buy)	36	40	49	85	87	69	68	92	69	66	67	77
	N(Sell)	41	33	83	57	77	64	59	61	76	70	78	67
	Buy	0.0005	-0.0023	0.0039	0.0049	0.0075	0.0038	0.0098	0.0179	0.0134	0.0127	0.0179	0.0133
		(0.1575)	(1.7418)	(1.9049)	***(2.4889)***	***(3.6686)***	(2.3288)	***(5.4464)***	***(10.8867)***	***(6.6060)***	(4.6169)	***(6.4690)***	***(7.4807)***
	Sell	0.0023	-0.0075	-0.0022	-0.0065	-0.0043	-0.0022	-0.0045	-0.0188	-0.0041	-0.0031	-0.0047	-0.0041
		(1.4573)	(5.0103)	(1.2002)	***(3.0410)***	***(2.0362)***	(1.3869)	***(2.4205)***	***(9.5738)***	***(2.0709)***	(1.2829)	***(1.9618)***	***(2.2782)***
	Buy-Sell	-0.0018	0.0052	0.0061	0.0114	0.0118	0.006	0.0143	0.0367	0.0175	0.0158	0.0226	0.0174
		(0.8854)	(2.5458)	(2.2560)	***(3.9581)***	***(4.0321)***	(2.6330)	***(5.5213)***	***(14.4131)***	***(6.2576)***	(4.2420)	***(6.1321)***	***(6.8221)***
(1,150,0)	N(Buy)	119	79	61	102	82	91	86	91	58	69	65	66

	N(Sell)	34	34	59	31	55	31	37	40	47	41	47	42
	Buy	0.0011	0.0015	-0.003	0.0052	0.0017	0.0048	0.009	0.0118	0.0126	0.0108	0.01	0.0056
		(1.0096)	(1.4458)	(1.4259)	(2.8960)	(0.7517)	***(3.3832)***	***(5.6506)***	***(7.0902)***	***(5.7029)***	***(4.0184)***	(3.4337)	***(2.8863)***
	Sell	0.0023	-0.007	0.0072	0.0002	-0.0028	-0.0166	-0.0039	-0.0235	-0.0045	-0.0048	-0.0037	-0.0062
		(1.3735)	(4.8092)	(3.7738)	(0.0521)	(1.1353)	***(7.0792)***	***(1.6711)***	***(9.7062)***	***(1.7950)***	***(4.0184)***	(1.2214)	***(2.7049)***
	Buy-Sell	-0.0012	0.0085	-0.0102	0.005	0.0045	0.0214	0.0129	0.0353	0.0171	0.0156	0.0135	0.0118
		(0.7338)	(4.8354)	(3.7137)	(1.4590)	(1.3638)	***(7.8559)***	***(4.5302)***	***(12.0798)***	***(5.1797)***	***(3.6465)***	(3.1789)	***(3.9365)***
(1,150,0.01)	N(Buy)	23	21	28	59	54	45	44	57	39	45	42	47
	N(Sell)	23	20	48	22	41	26	33	30	43	33	40	35
	Buy	-0.0017	-0.0067	0.0056	0.0072	0.0073	0.0046	0.0056	0.015	0.0137	0.0132	0.0187	0.0033
		(1.0018)	(3.5817)	(2.0597)	(3.1163)	(2.7950)	(2.2788)	***(2.5122)***	***(7.1766)***	***(5.1060)***	(3.9600)	(5.3599)	(1.4038)
	Sell	0.0002	-0.0083	-0.0008	-0.0001	-0.0032	-0.0032	-0.0041	-0.0155	-0.0047	-0.0021	-0.0039	-0.0038
		(0.0174)	(4.3554)	(0.2709)	(0.1175)	(1.1176)	(1.2955)	***(1.6576)***	***(5.5902)***	***(1.7953)***	(0.7479)	(1.846)	(1.5527)
	Buy-Sell	-0.0019	0.0016	0.0064	0.0073	0.0105	0.0078	0.0097	0.0305	0.0184	0.0153	0.0226	0.0071
		(0.6978)	(0.6166)	(1.8070)	(1.7370)	(2.6929)	(2.4198)	***(2.9097)***	***(8.7790)***	***(4.9566)***	(3.4184)	(4.6157)	(2.1016)
(1,200,0)	N(Buy)	111	72	53	97	70	83	75	85	48	62	61	58
	N(Sell)	27	29	55	25	48	28	31	28	38	32	36	36
	Buy	0.0013	0.0011	-0.0025	0.0061	0.0032	0.0045	0.0088	0.0121	0.0129	0.0134	0.0136	0.0079
		(1.2633)	(1.0158)	(1.0999)	(3.3280)	(1.3844)	***(3.0062)***	(5.1409)	***(7.0554)***	***(5.3252)***	(4.7402)	(4.6547)	***(3.8237)***
	Sell	0.0026	-0.005	0.0111	-0.0034	-0.0033	-0.0203	-0.0012	-0.0274	-0.0098	0.0028	0.0016	-0.0075
		(1.3667)	(3.2005)	(5.5726)	(1.0942)	(1.2451)	***(8.2332)***	(0.4992)	***(9.4431)***	***(3.5414)***	(0.6518)	(0.3575)	***(3.0129)***
	Buy-Sell	-0.0013	0.0061	-0.0136	0.0095	0.0065	0.0248	0.01	0.0375	0.0227	0.0106	0.012	0.0154
		(0.6639)	(3.2590)	(4.7158)	(2.5002)	(1.8534)	***(8.6638)***	(3.2236)	***(11.7581)***	***(6.2142)***	(2.2561)	(2.5730)	***(4.7566)***
(1,200,0.01)	N(Buy)	21	19	26	57	47	43	40	55	31	40	40	42

	N(Sell)	17	17	46	18	34	24	28	21	35	26	33	29
	Buy	-0.0012	-0.0097	0.0047	0.0077	0.0059	0.0044	0.0095	0.0169	0.0193	0.0155	0.0187	0.0052
		(0.7253)	(4.9601)	(1.6829)	(3.2748)	(2.1234)	(2.1329)	(4.0717)	***(7.9637)***	***(6.3958)***	(4.4253)	(5.2265)	(2.1246)
	Sell	-0.0029	-0.0084	0.0035	-0.0035	-0.0041	-0.0034	-0.003	-0.0259	-0.0099	0.0093	0.0007	-0.0004
		(1.4222)	(4.0553)	(1.6748)	(0.9614)	(1.2973)	(1.3127)	(1.1283)	***(7.74775)***	***(3.4447)***	(2.1045)	(0.1102)	(0.2128)
	Buy-Sell	0.0017	-0.0013	0.0012	0.0112	0.01	0.0078	0.0125	0.0428	0.0292	0.0062	0.018	0.0056
		(0.5730)	(0.4639)	(0.3375)	(2.4538)	(2.3743)	(2.3367)	(3.4918)	***(10.8163)***	***(7.0425)***	(1.1479)	(3.4502)	(1.5280)
AVERAGE	N(BUY)	78	58	54	90	78	77	73	86	59	64	63	66
	N(SELL)	35	36	67	38	59	42	45	44	55	49	56	49
	BUY	0.0003	-0.0023	0.0012	0.0061	0.0049	0.0044	0.0088	0.0148	0.0141	0.0136	0.0147	0.0083
		(0.0829)	(0.0923)	(0.6908)	(3.2374)	(2.2676)	***(2.8175)***	***(5.0592)***	***(8.6723)***	***(6.4137)***	(4.8441)	(5.0999)	***(4.2894)***
	SELL	0.0009	-0.0064	0.0035	-0.0031	-0.0038	-0.0096	-0.0035	-0.0166	-0.0062	-0.0007	-0.0024	-0.0048
		(0.4516)	(0.4750)	(1.9914)	(1.2535)	(1.5643)	***(4.8188)***	***(1.6484)***	***(7.1624)***	***(2.6826)***	(0.2983)	(0.8920)	***(2.2699)***
	BUY-SELL	-0.0006	0.0041	-0.0023	0.0092	0.0087	0.0140	0.0123	0.0314	0.0203	0.0143	0.0171	0.0131
		(0.3294)	(0.2326)	(0.8279)	(2.8419)	(2.6865)	***(5.5799)***	***(4.4413)***	***(10.9384)***	***(6.4298)***	(3.4411)	(4.1754)	***(4.5502)***

Table 4.4 presents results of TRB rules for daily data from 1991-2008. Cumulative returns are reported for 10-day holding period after signals are detected. Rules are identified by (short, long, band). Buy-and-hold returns are the mean unconditional 10-day returns for each of the stock market index. N(Buy) and N(Sell) are the number of buy and sell signals generated during the sample period. Numbers in parentheses are standard t-statistics using a two-tailed test. T-statistics value is greater than 2.576 indicates statistical significance at 1% level, greater than1.96 indicates statistical significance at 5% level, and greater than 1.64 indicates statistical significance at 10% level. The Bond and Italic t-test values in the parentheses indicate the statistical significance at 1%, 5%, or 10% levels.

4.6. Profitability of technical trading rules

We next provide some information on the degree to which investors using these technical trading rules could earn trading profits with the inclusion of transaction costs in our sample period. The ex-post trading profits of technical trading rules depend on 1) the trading strategy itself, that is, the positions taken on days with buy signals compared to positions taken on days with sell signals, 2) mean returns on buy days versus mean returns on sell days, and 3) the magnitude of transaction costs incurred when the positions are changed (Ratner and Leal, 1999). To evaluate the profitability of technical trading rules, we use a "double or out" strategy proposed by Brock et al. (1992) and Bessembinder and Chan (1995, 1998). Under this strategy, investors borrow at the risk-free rate in order to double their investments in the index when there is a buy signal, sell and invest in a risk-free asset when there is a sell signal, but hold a long stock position when no signal is generated. Following this strategy, we compute the additional returns (π) before transaction costs generated by the technical trading rules relative to a buy-and-hold strategy. We compute the breakeven transaction costs and compared these with the estimated actual transaction costs from implementing the technical trading rules. Previous studies showed that technical trading rules have the predictive ability but can not generate excess returns in a costly trading environment (Hudson et al., 1996; Bessembinder and Chan, 1998). This study also examines whether the technical trading rules can generate excess returns for investors when transaction costs are taken into consideration.

Table 4.5 reports the breakeven costs, which are the percentage round-trip costs needed to offset the additional returns earned by the technical trading rules relative to a buy-and-hold strategy. Table 4.5 shows the breakeven costs for 12 variable-length

moving average trading rules for 12 stock market indices in Panel A, 12 fixed-length moving average trading rules for 12 stock market indices in Panel B, and 6 trading range breakout rules for 12 stock market indices in Panel C. The estimated actual transaction costs are reported at the bottom row of each panel in Table 4.5. The study used Bessembinder and Chan's (1995) procedure to estimate the actual round-trip transaction costs for Malaysia, Japan, South Korea, Hong Kong, and Thailand stock markets; Ratner and Leal's (1999) procedure for the Indonesian stock market; Domowitz, Glen, and Madhavan (2001) for the Australian stock market, and trading fees reported on the Stock Exchange website for New Zealand, Shanghai, Shenzhen, Singapore, and the Philippine stock markets. The estimated actual round-trip transaction costs for investments of $100,000 include brokerage fees and transaction taxes.

The results show the breakeven costs for some rules in some stock markets (e.g. TRB rules in Australia and Japan) are negative, indicating that even those who can trade at zero transaction cost would have earned less returns by trading on the technical rules than from a simple buy-and-hold strategy. Investors who adopt the TRB rules in the Australian and Japanese stock markets would not profit. This may be because the two developed stock markets are more efficient than other stock markets, since using the technical trading rules can not outperform a simple buy-and-hold strategy.

We compare the computed round-trip breakeven costs with the estimated actual round-trip transaction costs for the Asia-Pacific stock markets. For example, the data in Panel A in Table 4.5 shows profits after transaction costs from the VMA technical trading rules are unlikely in any of the stock markets we tested. The breakeven costs

for each VMA trading rule are small compared to the estimate transaction costs and thus can not generate excess returns for investors after transaction costs are included in the twelve stock markets.

Panel B in Table 4.5 shows the breakeven costs for the FMA trading rules. The results show the Korean stock market has the most profitable FMA trading rules. Eight out of twelve FMA rules have higher breakeven costs than the estimated transaction costs. The Hong Kong stock market has five FMA rules, Thailand stock markets has two FMA rules, Shanghai stock market has three FMA rules and the Shenzhen stock market has five FMA rules, whose breakeven costs are higher than the estimated actual trading costs. However, as shown in the bottom of Panel B only the Korean stock market can generate excess returns after adjusting for transaction costs.

Panel C in Table 4.5 shows the breakeven costs for the TRB trading rules. The results show that only Thailand and Shenzhen stock markets have the average breakeven costs that are greater than the estimated transaction costs. None of the developed stock markets except Korea is profitable after adjusting for transaction costs in Panel C. The mean breakeven costs for each of the developed stock markets are less than their estimated actual transaction costs. However, the possibility of technical trading profits can not be dismissed in Thailand and Shenzhen stock markets. The mean breakeven costs of the TRB trading rules for the two emerging stock markets are greater than their respective estimated transaction costs. However, the technical trading rules can successfully forecast the stock price movements in Malaysia, Indonesia, Shanghai, and the Philippine stock markets, but are unprofitable due to high transaction costs incurred in these stock markets.

Our results for the Thailand stock market are consistent with the results of Bessembinder and Chan (1995) and Ratner and Leal (1999). Bessembinder and Chan (1995) indicated that the trading rules have the profitability in the emerging stock markets of Malaysia, Thailand, and Taiwan. However, our results also show that the technical trading rules are unprofitable with the inclusion of transaction costs in the Malaysian stock market. Ratner and Leal (1999) supported this result, as they find no strong evidence of profitability in the Malaysian stock market. Furthermore, our results show the profitability of technical trading rules for the Korea and Shenzhen stock markets. This result is consistent with recent findings by Lento (2007) for the Korean stock market and Cai et al. (2005) for the Shenzhen stock market. The estimated breakeven costs for the TRB trading rules for both Shanghai and Shenzhen stock markets are similar to those reported by Cai et al. (2005), who reported that the technical trading rules are profitable in the Chinese stock markets.

Overall, the empirical results show that traders who incur round-trip transaction costs which are less than the breakeven costs could have generated higher returns by implementing technical trading rules than from a simple buy-and-hold strategy. We find that trading rules can beat the buy-and-hold strategy even after adjusting for transaction costs in Thailand, Shenzhen, and Korea stock markets. This result supports Hypothesis 2 that the breakeven costs for the technical trading rules are greater than the estimated actual transaction costs. This implies that the technical trading rules are profitable in these Asia-Pacific stock markets. There is no evidence of profitability of technical trading rules in other stock markets. However, the estimated actual transaction costs reported in Table 4.5 is not definitive, and may

overstate the costs of transacting since large scale traders (who invest more than $100,000) or market insiders may incur costs that are less than our estimates.

Table 4.5 Breakeven cost for the "double or out" strategy

Panel A: VMA rules												
	Developed Stock Markets						Emerging Stock Markets					
Rules	Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
(1,50,0)	0.03%	0.02%	0.03%	0.08%	0.10%	0.06%	0.09%	0.15%	0.12%	0.11%	0.14%	0.11%
(1,50,0.01)	0.03%	0.03%	0.05%	0.10%	0.09%	0.08%	0.10%	0.16%	0.13%	0.11%	0.15%	0.13%
(1,150,0)	0.01%	0.01%	0.03%	0.05%	0.07%	0.06%	0.07%	0.08%	0.07%	0.05%	0.11%	0.08%
(1,150,0.01)	0.02%	0.01%	0.03%	0.06%	0.08%	0.07%	0.07%	0.08%	0.08%	0.05%	0.11%	0.09%
(1,200,0)	0.02%	0.01%	0.03%	0.05%	0.07%	0.04%	0.08%	0.07%	0.06%	0.05%	0.11%	0.07%
(1,200,0.01)	0.02%	0.01%	0.04%	0.05%	0.07%	0.05%	0.09%	0.08%	0.07%	0.06%	0.12%	0.08%
(2,200,0)	0.02%	0.01%	0.04%	0.05%	0.07%	0.04%	0.07%	0.07%	0.07%	0.05%	0.09%	0.05%
(2,200,0.01)	0.02%	0.01%	0.04%	0.05%	0.07%	0.05%	0.08%	0.08%	0.08%	0.06%	0.09%	0.05%
(5,150,0)	0.02%	0.01%	0.03%	0.04%	0.06%	0.06%	0.06%	0.05%	0.04%	0.06%	0.07%	0.07%
(5,150,0.01)	0.02%	0.01%	0.04%	0.05%	0.06%	0.06%	0.07%	0.06%	0.04%	0.06%	0.08%	0.07%
(5,200,0)	0.02%	0.01%	0.03%	0.05%	0.08%	0.05%	0.05%	0.07%	0.02%	0.03%	0.09%	0.05%

(5,200,0.01)	0.02%	0.01%	0.04%	0.05%	0.07%	0.04%	0.05%	0.08%	0.03%	0.04%	0.09%	0.06%
Average	0.02%	0.01%	0.04%	0.06%	0.07%	0.05%	0.07%	0.09%	0.07%	0.06%	0.11%	0.07%
Estimated costs	**1%**	**1.20%**	**1.64%**	**1.20%**	**1.22%**	**2.00%**	**2.80%**	**2.50%**	**1.00%**	**1.00%**	**0.80%**	**2.00%**
Panel B: FMA Rules												
Rules	Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
(1,50,0)	0.07%	-0.15%	-0.21%	-0.11%	0.67%	0.19%	0.14%	1.87%	0.89%	1.24%	0.97%	0.59%
(1,50,0.01)	0.17%	0.30%	0.30%	0.16%	1.08%	0.24%	0.02%	1.92%	1.04%	1.07%	1.33%	0.69%
(1,150,0)	0.12%	-0.02%	-0.34%	0.22%	1.20%	0.10%	0.52%	0.90%	0.59%	-1.06%	1.50%	0.81%
(1,150,0.01)	0.02%	0.15%	0.58%	0.04%	1.19%	0.52%	0.76%	0.77%	0.68%	-0.28%	1.66%	1.62%
(1,200,0)	0.21%	0.32%	0.61%	0.47%	2.55%	0.09%	0.94%	0.56%	0.20%	0.12%	0.46%	0.99%
(1,200,0.01)	-0.08%	0.52%	0.38%	1.96%	2.29%	0.12%	1.01%	0.65%	0.25%	0.21%	0.46%	0.85%
(2,200,0)	-0.26%	0.37%	0.10%	1.57%	2.44%	0.13%	0.20%	0.92%	0.29%	0.03%	1.10%	0.62%
(2,200,0.01)	0.28%	0.41%	-0.04%	1.62%	2.46%	0.13%	0.38%	0.73%	0.11%	-0.21%	0.33%	0.90%
(5,150,0)	-0.02%	0.08%	0.76%	0.98%	1.69%	0.43%	0.88%	0.34%	0.77%	-0.15%	0.41%	1.49%

(5,150,0.01)	-0.38%	0.12%	1.14%	0.10%	1.46%	0.10%	1.60%	1.17%	1.07%	0.13%	-0.21%	1.52%
(5,200,0)	0.20%	0.45%	0.38%	1.18%	2.22%	0.09%	0.76%	0.85%	0.51%	-0.38%	0.62%	1.80%
(5,200,0.01)	0.55%	0.27%	-0.40%	2.45%	2.04%	0.14%	0.94%	0.58%	0.92%	-0.78%	0.04%	1.57%
Average	0.07%	0.23%	0.27%	0.89%	***1.77%***	0.19%	0.68%	0.94%	0.61%	0.00%	0.72%	1.12%
Estimated costs	**1%**	**1.20%**	**1.64%**	**1.20%**	**1.22%**	**2.00%**	**2.80%**	**2.50%**	**1.00%**	**1.00%**	**0.80%**	**2.00%**
Panel C: TRB Rules												
Rules	Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
(1,50,0)	0.10%	0.23%	-0.18%	0.56%	0.44%	0.71%	0.77%	1.63%	0.87%	1.13%	0.67%	1.09%
(1,50,0.01)	-0.10%	0.21%	0.28%	0.55%	0.60%	0.30%	0.73%	1.43%	0.85%	0.78%	1.08%	0.90%
(1,150,0)	0.03%	0.32%	-0.51%	0.39%	0.21%	0.78%	0.75%	1.54%	0.90%	0.86%	0.74%	0.58%
(1,150,0.01)	-0.10%	0.06%	0.26%	0.53%	0.55%	0.41%	0.50%	1.52%	0.90%	0.85%	1.15%	0.35%
(1,200,0)	0.05%	0.22%	-0.69%	0.55%	0.32%	0.85%	0.66%	1.59%	1.15%	0.79%	0.80%	0.77%
(1,200,0.01)	0.06%	-0.12%	-0.05%	0.67%	0.51%	0.40%	0.68%	1.39%	1.43%	0.57%	0.99%	0.32%
Average	0.01%	0.15%	-0.15%	0.54%	0.44%	0.58%	0.68%	1.51%	***1.02%***	0.83%	***0.90%***	0.67%

Estimated costs	**1%**	**1.20%**	**1.64%**	**1.20%**	**1.22%**	**2.00%**	**2.80%**	**2.50%**	**1.00%**	**1.00%**	**0.80%**	**2.00%**

Mean breakeven cost (%) for the "double or out" strategy (borrow to double long positions in the stocks on buy signals and invest in risk-free assets on sell signals) relative to the buy-and-hold strategy. Buy and sell signals are generated from variable-length moving average (VMA), fixed-length moving average (FMA) with 10 days holding period, and trading range breakout rules (TRB) with 10 days holding period. The bottom row reports the estimated actual round-trip transaction costs for 12 stock market indices. All estimated round-trip transaction costs for each country include brokerage fees and transaction taxes.

4.7. Relationship between market efficiency and the profitability of technical trading rules

Profitability of technical trading rules in emerging stock markets may be associated with the persistence of returns, or autocorrelation, in these markets (Ratner and Leal, 1999). Harvey (1995a) reported in his study that the autocorrelation in emerging stock markets is much higher than in developed stock markets. The high autocorrelation indicates that stock prices do not necessarily follow a random walk in the stock markets. Many researchers examined the profitability of technical trading rules in emerging and developed stock markets and find that the technical trading rules can beat the simple buy-and-hold strategy and earn excess returns in the emerging stock markets (Bessembinder and Chan, 1995, 1998; Tian et al., 2002; Cai et al., 2005; Lento, 2007; Marshall et al., 2009).

In order to test the relationship between market efficiency and excess return, we compare the excess returns generated by the technical trading rules between six developed stock markets and six emerging stock markets during the test period from 1991 to 2008. The data on mean returns generated by the technical trading rules reported in Tables 4.2 to 4.4 shows that the average buy-sell returns earned by the technical trading rules (VMA, FMA and TRB) are statistically significantly higher for the emerging stock markets than those for the developed stock markets. For example, the average buy-sell returns across six emerging stock markets and all technical trading rules are: 0.16% for the VMA rules, 1.41% for the FMA rules, and 1.80% for

the TRB rules. In contrast, the average buy-sell returns across six developed stock markets and all trading rules are: 0.08% for the VMA rules, 1.18% for the FMA rules, and 0.55% for the TRB rules. These results show that the technical trading rules in the emerging stock markets can earn more profits before adjusting for transaction costs than those in the developed stock markets.

Technical trading rules can generate pre-transactions cost profits for these Asia-Pacific stock markets, but high trading costs could eliminate these profits. Table 4.5 reports the breakeven costs for each technical trading rule required to eliminate the additional returns earned by the technical trading rules relative to a simple buy-and-hold strategy. A comparison of the three panels in Table 4.5 reveals that, with the exception of the Korean stock market in Panel B, all other five developed stock markets have lower average breakeven costs (across all rules) than the estimated actual transaction costs. This means that the transaction costs offset the trading profits earned by the technical trading rules for these developed stock markets. The average breakeven costs across all the rules are higher than the estimated transaction costs for the emerging stock markets of Thailand and Shenzhen as reported in Panel C of Table 4.5. This indicates that the transaction costs do not eliminate the trading profits in two of the emerging stock markets.

The findings have implications on stock market efficiency in these countries. The empirical results distinctly show that the technical trading rules performed better in the emerging stock markets than in the developed stock markets. It supports Hypothesis 3 that the technical trading rules are more profitable in emerging stock markets than in developed stock markets. The trading rules performed worse on the developed stock markets of Australia, New Zealand, Singapore, and Japan. These results are expected as they are the most efficient developed stock markets in the Asia-Pacific region among those we tested. Therefore, implementing technical trading rules in these stock markets can not earn excess returns for investors after transaction costs included.

Most of the emerging stock markets' institutional structures raise some questions about their efficiency relative to their US or European counterparts. Some Asian stock markets are dominated by a few large companies with ownership concentrated in the hands of a small number of investors. Insider trading is relatively high. In addition, the requirements for financial disclosures are less regulated, leading to a scarcity of publicly available information (Bessembinder and Chan, 1995). If the Asian stock markets are in fact relatively inefficient, then technical analysis may be able to exploit the inefficiencies. Our results show that the technical trading rules are successful in the stock markets of Korea, Thailand, and Shenzhen; and have less explanatory power in more developed stock markets such as Australia, New Zealand, Hong Kong,

Singapore, and Japan. High transaction costs incurred in the other emerging stock markets make technical trading rules unprofitable. In addition, Ratner and Leal (1999) explained that microstructure issues such as the brokerage fees and other costs, at the country level, may explain why the technical trading rules are profitable in one country but not in another, even though they demonstrate comparable market inefficiency.

4.8. Conclusion

This chapter discusses the empirical results of the variable-length moving average rules (VMA), the fixed-length moving average rule (FMA), and the trading range break-out rules (TRB). We use both daily inflation adjusted returns and raw daily returns (not adjusted for inflation) to compute the technical trading returns. The results show that the mean daily inflation adjusted series is nearly the same as the unadjusted series. In this study, we not only test the technical trading rules with a 1% band, but also include bands of 0.5% and 3%. Our results show that returns generated by the technical trading rules with band of 0.5% are similar to returns generated by the trading rules with band of 1%. And the technical trading rules with band of 3% are too high and filter out many buy and sell signals. For the TRB trading rules, rules with a 3% band can not generate any signals for Australia stock market. Consistent with Brock et al. (1992) and Bessembinder and Chan's (1995) results, we can conclude that the technical trading rules have considerable predictive ability and profitability in

the Asia-Pacific stock markets. The buy signals generate positive returns and sell signals generate negative returns which are, on average, significantly different from the returns earned by a simple buy-and-hold strategy. Our results show the trading rules have stronger predictive power in the emerging stock markets than in the developed stock markets. In addition, we observe that the short-term variants of the technical trading rules may be more useful in detecting the predictive ability of these technical trading rules.

Second, in the examination of profitability of technical trading rules, we find that transaction costs play an important role; it eliminates trading profits for most stock markets. Our results show that the trading rules are profitable in Thailand, Shenzhen, and Korea stock markets after adjusting for transaction costs. There is no evidence of profitability of the technical trading rules in other stock markets after considering for transaction costs.

Third, our study shows that the technical trading rules performed better in the emerging stock markets than in the developed stock markets. Technical trading rules are successful in the stock markets of Korea, Thailand, and Shenzhen; and have less explanatory power in more developed stock markets such as Australia, New Zealand, Hong Kong, Singapore, and Japan. Due to market inefficiencies in the emerging Asia-Pacific stock markets, using technical analysis may be able to exploit the

inefficiencies. Technical trading rules performed worse on developed stock markets of Australia, New Zealand, Singapore, Hong Kong, and Japan, which are considered as these stock markets support the weak-form EMH, and using technical trading rules can not be profitable.

CHAPTER FIVE

CONCLUSIONS

5.1. Introduction

This chapter summarizes the study on the predictive ability and profitability of technical trading rules in Asia-Pacific stock markets. Section 5.2 reviews the study. Section 5.3 discusses the findings and implications of the study. Section 5.4 discusses the limitation of the research, and Section 5.5 provides some recommendations for future research.

5.2. Overview of the study

Technical trading rules are considered as one of the earliest forms of investment tools because stock prices and volume levels have been publicly available before other types of financial information (Lento, 2007). Technical analysts attempt to predict stock market returns through identifying patterns in past stock market prices. Fama (1970) investigated the efficient market hypothesis (EMH), and defines an efficient financial market as one in which stock prices always fully reflect the available information. Any new information would be quickly and instantaneously reflected in the security prices. Fama (1970) classified the EMH into three forms: (a) weak-form, (b) semi-strong-form, and (c) strong-form market efficiency, according to the level of information investigated. The weak-form market efficiency asserts that all past market prices and data are fully reflected in the securities prices, suggesting that using trading

rules based on historical data are not profitable. Therefore, if the market is weak-form efficient, technical analysis based on investigating past stock market prices are useless.

Earlier empirical studies which investigate the EMH tests on whether different trading rules could earn profits, such as filter rules (Alexander, 1961, 1964; Fama and Blume, 1966; Sweeney, 1988), relative strength rules (Levy, 1976a, 1967b; Jenson and Benington, 1970; Brush and Boles, 1983; Jacobs and Levy, 1988), and moving average trading rules (Van Horne and Parker, 1967; James, Jr., 1968; Dale and Workman, 1980). These studies show that returns earned by using technical trading rules, based on exploiting trends in historic share price data, cannot outperform a buy-and-hold strategy, and the predictable variation in equity returns is economically and statistically very small. These studies concluded that by the early 1990s, it is not possible to outperform the market using technical trading rules.

Since the early 1990s, some researchers have found evidence that simple trading rules are useful for predicting stock market returns. For example, Brock et al. (1992) investigated two simple technical trading rules: moving average trading rules (MA) and trading range breakout rule (TRB). Brock et al. (1992) showed that the two simple trading rules have significant predictive power for the US equity index returns. Bessembinder and Chan (1998) further investigated Brock et al.'s (1992) study and

adjusted for transaction costs and non-synchronous trading for the US equity market. Their results confirmed Brock et al.'s (1992) results, and concluded that the simple forms of technical trading rules contain significant predictive power for the US equity index returns, but the inclusion of transaction costs and adjustment for non-synchronous trading eliminate the technical trading rules profits.

In the relatively new and emerging Asia-Pacific stock markets, Bessembinder and Chan (1995) provided evidence to support the usefulness of technical trading rules. They are amongst the first to show that the moving average and trading range breakout technical trading rules have predictive ability to forecast stock price movements for six Asian stock markets. In general, Bessembinder and Chan (1995) found that the technical trading rules are successful in predicting stock price movements in the emerging stock markets of Malaysia, Thailand, and Taiwan; but have less explanatory power in the more developed stock markets of Hong Kong and Japan. Other previous researches also based their studies on the Asia-Pacific stock markets, including Ito (1999) for Japan, US, Canada, Indonesia, Mexico, and Taiwan stock markets; Tian et al. (2002) for the US and China stock markets; Cai et al. (2005) for the US, UK, Hong Kong, Japan, and China stock markets; and Lento (2007) for Australia, India, Indonesia, Korea, Japan, Hong Kong, Singapore, and Taiwan stock markets. These studies arrived at the similar conclusion whereby the technical trading

rules perform better in the emerging stock markets than in the developed stock markets.

This study examines the predictive ability and profitability of the two simple trading rules-moving average (MA) and trading range breakout (TRB) rules for twelve Asia-Pacific stock markets with different efficiency levels from January 1, 1991 to December 31, 2008. These include Australia, New Zealand, Japan, Hong Kong, South Korea, Singapore, Malaysia, Indonesia, Thailand, Shanghai, Shenzhen, and the Philippines stock markets.

Brock et al. (1992) defined two versions of the general moving average trading rules: the variable length moving average (VMA) and the fixed length moving average (FMA). According to Brock et al. (1992), the VMA trading rule generates buy (sell) signals when the short moving average is above (below) the long moving average by an amount larger than the band. The FMA trading rule generates a buy (sell) signal when the short-run moving average cuts the long-run moving average from below (above) (Brock et al., 1992). Different from the VMA trading rule, once a buy or sell signal is detected, the FMA rule calls for the investors to stay in the same position (either buy or sell) for a fixed number of days, usually 10 days. The returns for the next 10-day period are recorded. The trading range breakout rule generates a buy (sell) signal as the stock price penetrates the previous maximum (minimum) prices (Brock

et al., 1992). This study examines the effectiveness of the VMA, FMA, and TRB technical trading rules. Three research objectives are set for this study. Objective one examines whether the technical trading rules can predict stock price movements. Objective two tests whether using the technical trading rules can generate excess returns after considering for transaction costs. Objective three investigates the relationship between market efficiency and excess returns by applying the technical trading rules.

This study differs from other studies in several ways. First, this study provides a more comprehensive examination of technical trading rules on Asia-Pacific stock markets. This study uses more recent data to examine 60 technical trading rules (both MA and TRB) in twelve Asia-Pacific stock markets. As discussed before, previous studies have focused on the Asian stock markets (Bessembinder and Chan, 1995, Cai et al., 2005), but little research tested the Asia-Pacific region (including Australia and New Zealand stock markets). This study covers twelve stock markets and compares the effectiveness of the technical trading rules in this region. Second, we use daily inflation adjusted returns instead of nominal returns to compute trading returns. This is important since high level of inflation is present in many of the emerging Asia-Pacific stock markets. Most previous studies have used nominal returns to calculate the technical trading returns except for Ratner and Leal (1999), who tested the variable-length moving average trading rules (VMA) in ten emerging stock

markets of Latin America and Asia (India, Korea, Malaysia, Taiwan, Thailand, and the Philippines) and use daily inflation adjusted returns to calculate the technical trading returns. Our study differs from Ratner and Leal (1999) as we examine more technical trading rules (VMA, FMA and the TRB trading rules) in twelve Asia-Pacific stock markets. In addition, we compare the difference of the technical trading returns both with inflation adjustment and without inflation adjustment. Third, we do not only test the technical trading rules with a 1% band as previous studies (Brock et al., 1992; Bessembinder and Chan, 1995, 1998), but also compare the difference when implementing trading rules with bands of 0%, 0.5%, 1%, and 3%.

Furthermore, our study investigates the efficient market hypothesis (EMH) by studying whether the technical trading rules based on exploiting historical price data are profitable, and contributes to the overall understanding of the efficiency and pricing behaviour of the Asia-Pacific stock markets.

5.3. Results and Implications

5.3.1. Results for research objective one and implications

We test the predictive ability of the technical trading rules. For the trading rules to be effective, the average buy returns must be positive and the average sell returns must be negative, and must be statistically significantly different from the unconditional returns (buy-and-hold returns). Our findings show the standard statistical significance

for 46 VMA rules out of 144 (12 stock market indices with 12 VMA rules each); 51 FMA rules out of 144 (12 stock market indices with 12 VMA rules each); and 32 TRB rules out of 72 (12 stock market indices with 6 VMA rules each). Furthermore, our results indicate that one-third of the technical trading rules this study tested have predictive ability, mostly in the five emerging stock markets of Malaysia, Indonesia, Thailand, Shenzhen and the Philippines. For the Shanghai stock markets, only the short-term variants of the technical trading rules show predictive ability. For example, the two significant VMA rules for the Shanghai stock market are (1,50,0) and (1,50,0.01), the short period is 1 day and the long period is 50 days. The long-term variants of the VMA rules are insignificant for the Shanghai stock market, such as when the short period are 2 or 5 days and the long period are 150 or 200 days. For the developed stock markets of Australia, New Zealand, Japan, and the Hong Kong, majority of the technical trading rules are insignificant. This implies that these trading rules are ineffective in the four developed stock markets.

The result is predictable given the stronger predictive power of the emerging markets revealed by Harvey (1995a, 1995b). Our results are consistent with Bessembinder and Chan (1995) and Ratner and Leal's (1999) findings, who found that the trading rules are successful in the emerging stock markets of Malaysia, Thailand and the Philippines. Lento (2007) indicated that the technical trading rules are useful and profitable for the Jakarta (Indonesia) and KOSPI (Korea) stock market indices. Our

results for the Chinese stock markets are similar to Cai et al.'s (2005) findings, suggesting that the technical trading rules have short term predictive ability in the Chinese stock markets.

The observation that the technical trading rules have predictive power in some Asia-Pacific stock market indices is consistent since these markets are inefficient at least in our sample period. The findings of this study clearly indicate that the technical trading rules have some degrees of predictive power in the stock markets of Malaysia, Indonesia, Thailand, Korea, Singapore, Shanghai, Shenzhen, and the Philippine. We can conclude that these stock markets are not weak-form efficient. In addition, the technical trading rules performed worse in Australia, New Zealand, Japan, and Hong Kong stock markets. Our results suggest that these markets support the weak-form efficient market hypothesis (EMH), where the stock prices fully reflect the available information and implementing the technical trading rules can not be profitable.

5.3.2. Results for research objective two and implications

We examine the profitability of the technical trading rules in twelve Asia-Pacific stock markets. Profitability is defined as returns in excess of the buy-and-hold strategy after accounting for transaction costs. We estimate the breakeven costs required to offset the additional returns generated by the technical trading rules relative to buy-and-hold strategy. Following this, the estimated breakeven costs are

compared with the actual transaction costs for each of the twelve Asia-Pacific stock markets tested. Our results show that three stock markets (Korea, Thailand, and Shenzhen) present profitable technical trading rules after adjusting for transaction costs. The average breakeven costs across all the TRB trading rules are greater than the estimated actual transaction costs for the stock markets of Thailand and Shenzhen. The average breakeven costs across all the FMA trading rules are greater than the estimated transaction costs for the stock market of Korea.

The results show the profits from the technical trading rules are unlikely in the developed stock markets except for the Korean stock market. The other developed stock markets are not profitable after adjusting for transaction costs. For the emerging stock markets of Thailand and Shenzhen, the TRB trading rules showed profitability. Although the technical trading rules are successful in forecasting stock price movements for Malaysia, Indonesia, Shanghai, and the Philippines stock markets, high transaction costs incurred in these stock markets, making these trading rules unprofitable. This implies that transaction costs can eliminate technical trading profits. Therefore, our technical trading profits for each stock market tested are sensitive to their estimated actual transaction costs. However, the estimated round-trip transaction costs for each stock market in our study are not definitive, it may overstate the costs of transacting since large scale traders (who invest more than $100,000) or market insiders may incur trading costs that are less than our estimates. For these large scale

and market inside traders, implementing technical trading rules may generate higher returns than the ordinary investors due to the lower trading costs incurred.

5.3.3. Results for research objective three and implications

Profitability of technical trading rules in emerging stock markets may be associated with the persistence of returns, or autocorrelation, in these markets (Ratner and Leal, 1999). Harvey (1995a) found that the autocorrelation in the emerging stock markets is much higher than in developed stock markets. The high autocorrelation indicates that stock prices do not necessarily follow a random walk in these stock markets. Emerging stock markets are less liquid and present more concentrated trading than many developed stock markets. It leads to information inefficiency in the emerging stock markets. Finally, the probability of insider trading is relatively high. Due to these considerations, it is expected that the technical trading rules would be more profitable in the emerging stock markets than in the developed stock markets. To test whether the technical trading rules performed better in the emerging stock markets than in the developed stock markets, this study compares the excess returns generated by the technical trading rules between six developed stock markets and six emerging stock markets during the sample period.

Our results indicate that the average buy-sell returns (pre-transaction costs) earned by technical trading rules are higher for the emerging stock markets than those for the

developed stock markets. All the buy-sell differences across six emerging stock markets and six developed stock markets are positive and the t-statistics for these differences are significant. For example, the average buy-sell returns across six emerging stock markets and all trading rules are: 0.16% for the VMA rules, 1.41% for the FMA rules, and 1.80% for the TRB rules. In contrast, the average buy-sell returns across six developed stock markets and all trading rules are: 0.08% for the VMA rules, 1.18% for the FMA rules, and 0.55% for the TRB rules. Although the technical trading rules can generate pre-transactions cost profits for these Asia-Pacific markets, high trading costs could eliminate the profits. We find that the technical trading rules are profitable in the stock markets of Korea, Thailand, and Shenzhen, and have less explanatory power in more developed stock markets such as Australia, New Zealand, Hong Kong, Singapore, and Japan.

The findings have implications on stock market efficiency in these countries. Our results distinctly show that the technical trading rules performed better in the emerging stock markets than in the developed stock markets. The research findings clearly show that the technical trading rules are profitable when implemented in three Asia-Pacific stock markets (Korea, Thailand, and Shenzhen) and we can conclude that these three stock markets are not weak-form efficient. The trading rules performed worse in the developed stock markets. Majority of the developed stock markets tested in this study show that implementing technical trading rules are unprofitable. This

implies that the developed stock markets are informationally efficient and support the weak-form EMH, where using technical analysis can not earn profits for investors.

In addition, it is difficult to conclude that the Korean stock market is an emerging stock market or developed stock market. FTSE Group distinguishes it as a developed stock market and MSCI Barra classified it as an emerging stock market as of April 2009. Regardless of the level of development, our findings show that the Korean stock market is inefficient and implementing technical analysis can be profitable.

5.3.4. Conclusion

This study examines the predictive ability and profitability of technical trading rules in twelve Asia-Pacific stock markets. Our results show that the technical trading rules have predictive ability and this ability can be exploited to generate excess returns for the stock markets of Korea, Thailand, and Shenzhen. Although the technical trading rules are successful in forecasting stock price movements for Malaysia, Indonesia, Shanghai and the Philippines stock markets, high transaction costs incurred in these markets eliminate the profits. This means the transaction costs can eliminate technical trading profits. For the developed stock markets of Australia, New Zealand, Japan, Hong Kong, and Singapore, majority of the technical trading rules do not have predictive ability.

Our findings have implications on the stock market efficiency in these countries. Technical trading rules performed better in the emerging stock markets than in the developed stock markets. Trading rules performed worse in the developed stock markets of Australia, New Zealand, Japan, Hong Kong and Singapore, suggesting that these stock markets support the weak-form efficient market hypothesis (EMH), where stock prices fully reflect all available information and implementing technical trading rules can not be profitable. This study also has implications for individual investors and portfolio managers. Our results are important because they provide investors with information about the Asia-Pacific stock markets that can be used to determine optimal asset allocations and to further diversify their portfolios. An investor chooses how to allocate his/her wealth optimally between a riskless stock and a risky one. If the technical trading rules can predict stock price movements, investors can effectively use this technical analysis to determine optimal asset allocations. For example, if the investor invests an optimal fixed proportion of his/her money into the stock market, say 80%, when there is no technical signal generated; he/she should invest more than 80% when a buy signal emitted by technical trading rules and less otherwise. Importantly, we find that for the large scale and market inside traders, implementing the technical trading rules may generate higher returns than the ordinary investors due to the lower trading costs incurred.

5.4. Limitations

First, the series price data used in all twelve stock market indices did not adjust for dividend payments. Therefore, this study does not contain information about the payment of dividends and may cause bias. However, Brock et al. (1992) and Draper and Paudyal (1997) concluded that the technical trading returns could not be altered with the inclusion of dividends. In addition, it is complicated to adjust for the dividend payments. For example, the dividend payments would differ substantially between buy and sell periods. Since this study uses an 18-year share price index data from twelve stock market indices, some information on dividend payments for these stock markets are not available during the sample period. Therefore, we do not include the dividend payments in this study. Second, this study did not adjust for daily risk-free interest rates they are assumed to be zero for all the twelve stock market. Daily risk-free interest rate data for these markets are not available. It is common to use a zero interest rate because of the complex difference between borrowing and saving rates, and the possibility of investors using arbitrage portfolios (Cai et al., 2006). Bessembinder and Chan (1995, 1998) argued that the bias created by a zero interest rate is relatively small compared to the magnitude of the buy versus sell day returns.

5.5. Recommendations for future research

This study investigates only the simple technical trading rules, namely moving average and trading range breakout rules. There are more complex trading rules that may generate greater returns than the simple buy-and-hold strategy. Future research should explore other technical trading rules like relative strength index (RSI) and Bollinger bands technical trading rules. Future studies should also explore the investment behaviour of different culture (e.g. North American, European, and Asian) and the returns generated by technical trading rules in each respective stock market.

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Appendices

Appendix 1: Empirical results of the variable-length moving average trading rules (VMA) with bands of 0%, 0.5%, 1%, and 3%

Appendix 1 shows the mean daily inflation adjusted returns generated by the VMA rules with bands of 0%, 0.5%, 1% and 3%. The results show that the trading rules without a band generate the highest number of signals; rules with bands of 0.5%, 1% and 3% are ranked second, third and fourth, respectively. The highest returns are generated by the VMA rules with bands of 3%, and rules with bands of 1%, 0.5% and 0% are ranked second, third and fourth, respectively. In Appendix 1, the buy-sell returns generated by the VMA rules with bands of 0.5% and 1% are very similar for all twelve stock markets. For example, the mean daily returns of (1,50,0.005) rules for Korea, Singapore, Malaysia, and Indonesia stock markets are 0.19%, 0.14%, 0.17%, and 0.32%, respectively. The mean daily returns of (1,50,0.01) rules for the above four stock markets are 0.18%, 0.15%, 0.19%, and 0.31%, respectively. Returns generated by the VMA rules with a band of 3% are higher than with bands of 0%, 0.05%, and 1%. For the same four stock markets, the mean daily returns generated by (1,50,0.03) rules are 0.21%, 0.22%, 0.24%, and 0.37%, respectively. It clearly shows that the mean daily returns generated by the (1,50,0.03) rules are higher than returns generated by the (1,50,0.005) and (1,50,0.01) rules. These results reveal that the technical trading profits are larger for the VMA trading rules with higher bands.

Appendix 1: Empirical results of the variable-length moving average trading rules (VMA) with bands of 0%, 0.5%, 1%, and 3%

VMA rules adjusted for inflation													
		Developed Stock Markets						Emerging Stock Markets					
		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns		0.0215%	0.0104%	-0.0212%	0.0323%	0.0087%	0.0127%	0.0107%	0.0213%	-0.0077%	0.0237%	0.0273%	0.0202%
Rules													
(1,50,0)	N(Buy)	2913	2557	2204	2795	2418	2567	2554	2650	2310	1937	1917	2488
	N(Sell)	1733	2089	2442	1851	2228	2079	2092	1996	2336	1904	1924	2158
	Buy	0.0004	0.00025	0.00007	0.00099	0.001	0.00066	0.0009	0.0015	0.001	0.0013	0.0018	0.0011
		(0.7328)	(0.6996)	(0.7350)	***(1.6594)***	***(2.0117)***	***(1.6628)***	***(2.2202)***	***(3.5570)***	***(2.4660)***	***(1.6826)***	***(2.4685)***	***(2.4292)***
	Sell	-0.0001	-1.E-04	-0.0005	-0.0005	-0.0009	-0.0006	-0.0008	-0.0015	-0.0013	-0.0008	-0.0011	-0.0011
		(1.2619)	(0.9403)	(0.8229)	***(1.8652)***	***(2.1002)***	***(2.1486)***	***(2.3750)***	***(4.2178)***	***(2.7852)***	***(1.6996)***	***(2.3845)***	***(3.1792)***
	Buy-Sell	0.0005	0.00036	0.00057	0.0015	0.0019	0.0013	0.0017	0.0030	0.0023	0.0021	0.0029	0.0022
		(1.7388)	(1.4214)	(1.3446)	***(3.0309)***	***(3.5543)***	***(3.3015)***	***(3.9681)***	***(6.7184)***	***(4.5389)***	***(2.9227)***	***(4.1937)***	***(4.8583)***
(1,50,0.005)	N(Buy)	2647	2290	2037	2663	2297	2384	2373	2538	2175	1859	1835	2340
	N(Sell)	1506	1795	2264	1718	2110	1881	1901	1846	2233	1820	1848	2017
	Buy	0.0004	0.0003	0.0001	0.001	0.0010	0.0007	0.0008	0.0016	0.001	0.0013	0.0018	0.0011
		(0.7380)	(0.7727)	(0.6975)	***(1.6587)***	***(1.9576)***	***(1.8309)***	***(1.9959)***	***(3.6605)***	***(2.5484)***	***(1.6558)***	***(2.4323)***	***(2.3966)***
	Sell	-0.0001	-0.0002	-0.0004	-0.0007	-0.0009	-0.0007	-0.0009	-0.0016	-0.0014	-0.0008	-0.001	-0.0011
		(0.9727)	(1.1784)	(0.6090)	***(2.1493)***	***(2.0098)***	***(2.5279)***	***(2.7672)***	***(4.2719)***	***(2.9828)***	***(1.6739)***	***(2.0330)***	***(3.2452)***
	Buy-Sell	0.0005	0.0005	0.0005	0.0017	0.0019	0.0014	0.0017	0.0032	0.0024	0.0021	0.0028	0.0022
		(1.4481)	(1.6620)	(1.1162)	***(3.2585)***	***(3.3996)***	***(3.7295)***	***(4.0769)***	***(6.7843)***	***(4.7389)***	***(2.8572)***	***(3.8327)***	***(4.8393)***

(1,50,0.01)	N(Buy)	2379	1995	1879	2505	2210	2169	2169	2423	2054	1789	1748	2196
	N(Sell)	1295	1512	2082	1585	1988	1718	1741	1732	2123	1722	1765	1892
	Buy	0.0003	0.0003	0.0001	0.00105	0.001	0.0008	0.001	0.0016	0.0011	0.0014	0.0019	0.0013
		(0.5817)	(0.8930)	(0.6762)	***(1.7463)***	***(1.9260)***	***(1.9572)***	***(2.2622)***	***(3.6234)***	***(2.6065)***	***(1.8313)***	***(2.5489)***	***(2.7954)***
	Sell	-0.0002	-3.E-04	-0.0004	-0.0008	-0.0008	-0.0007	-0.0009	-0.0015	-0.0014	-0.0008	-0.0012	-0.0012
		(1.3300)	(1.3800)	(0.4672)	***(2.2057)***	***(1.8717)***	***(2.2186)***	***(2.7107)***	***(4.1727)***	***(3.0497)***	***(1.6424)***	***(2.3157)***	***(3.4226)***
	Buy-Sell	0.0005	0.00055	0.0005	0.0019	0.0018	0.0015	0.0019	0.0031	0.0025	0.0022	0.0031	0.0025
		(1.6327)	(1.8965)	(0.9667)	***(3.3425)***	***(3.2273)***	***(3.5100)***	***(4.1888)***	***(6.6083)***	***(4.8047)***	***(2.9575)***	***(4.1443)***	***(5.2749)***
(1,50,0.03)	N(Buy)	1145	934	1237	1811	1738	1390	1424	1950	1531	1424	1387	1634
	N(Sell)	646	770	1450	1138	1526	1130	1163	1345	1705	1354	1423	1401
	Buy	0.0003	0.0004	0.0003	0.0012	0.0012	0.0011	0.0012	0.0019	0.0014	0.0015	0.0019	0.0015
		(0.2407)	(0.8668)	(1.0446)	***(1.8841)***	***(2.1759)***	***(2.3282)***	***(2.4624)***	***(4.0307)***	***(3.0788)***	***(1.7939)***	***(2.4120)***	***(2.8847)***
	Sell	0.0001	-0.0002	-0.0003	-0.0008	-0.0009	-0.0011	-0.0012	-0.0018	-0.0015	-0.0009	-0.0013	-0.0013
		(0.2270)	(0.9701)	(0.0873)	***(2.0427)***	***(1.7795)***	***(2.7256)***	***(2.9033)***	***(4.1997)***	***(2.9194)***	***(1.6519)***	***(2.2908)***	***(3.1430)***
	Buy-Sell	0.0002	0.0006	0.0006	0.002	0.0021	0.0022	0.0024	0.0037	0.0029	0.0024	0.0032	0.0028
		(0.3548)	(1.4128)	(0.9303)	***(3.1618)***	***(3.2361)***	***(4.0295)***	***(4.2907)***	***(6.7278)***	***(4.9177)***	***(2.8368)***	***(3.8798)***	***(4.9031)***
(1,150,0)	N(Buy)	3125	2627	2034	2911	2465	2469	2604	2790	2220	2088	1882	2592
	N(Sell)	1421	1919	2512	1635	2081	2077	1942	1756	2326	1653	1859	1954
	Buy	0.0002	0.00012	0.00008	0.0006	0.0007	0.0006	0.0007	0.0009	0.0008	0.0007	0.0013	0.0009
		(0.1272)	(0.1203)	(0.7446)	(0.7533)	(1.3886)	(1.5284)	***(1.6707)***	***(1.8658)***	***(2.0276)***	(0.7741)	***(1.6499)***	***(1.8773)***
	Sell	0.00003	-1.E-05	-0.0005	-0.0003	-0.0006	-0.0005	-0.0006	-0.0006	-0.0007	-0.0003	-0.0008	-0.0007
		(0.6656)	(0.4470)	(0.6815)	(1.3841)	(1.5869)	(1.9945)	***(1.8037)***	***(1.8854)***	***(1.6404)***	(0.8704)	***(1.7171)***	***(2.2856)***

	Buy-Sell	0.00017	0.00013	0.00058	0.0009	0.0013	0.0011	0.0013	0.0015	0.0015	0.001	0.0021	0.0016
		(0.7216)	(0.5008)	(1.2273)	(1.8610)	(2.5639)	(3.0412)	***(2.9844)***	***(3.1953)***	***(3.0080)***	(1.4140)	***(2.8970)***	***(3.5869)***
(1,150,0.005)	N(Buy)	2986	2492	1963	2833	2414	2391	2522	2738	2117	2034	1813	2542
	N(Sell)	1310	1758	2426	1566	2034	1985	1859	1706	2224	1598	1801	1905
	Buy	0.0003	0.0001	0.0001	0.00064	0.00073	0.0007	0.0007	0.001	0.0008	0.0007	0.0014	0.0009
		(0.2531)	(0.2088)	(0.8424)	(0.7935)	(1.3764)	***(1.7150)***	***(1.6535)***	***(2.1247)***	***(1.9949)***	(0.7729)	***(1.7878)***	***(1.8655)***
	Sell	0.00003	-0.0001	-0.0006	-0.0003	-0.0007	-0.0005	-0.0006	-0.0005	-0.0008	-0.0004	-0.0009	-0.0008
		(0.7431)	(0.5019)	(0.7151)	(1.4346)	(1.6759)	***(1.7278)***	***(1.7956)***	***(1.6558)***	***(1.6697)***	(0.9743)	***(1.8570)***	***(2.3680)***
	Buy-Sell	0.0003	0.0002	0.0007	0.00094	0.00143	0.0012	0.0013	0.0015	0.0016	0.0011	0.0023	0.0017
		(0.8793)	(0.6167)	(1.3347)	(1.9288)	(2.6231)	***(2.9423)***	***(2.9449)***	***(3.1737)***	***(3.1352)***	(1.4985)	***(3.1187)***	***(3.6384)***
(1,150,0.01)	N(Buy)	2826	2327	1887	2744	2357	2324	2436	2667	2050	1963	1727	2489
	N(Sell)	1192	1606	2318	1497	1985	1892	1773	1655	2133	1550	1742	1851
	Buy	0.0003	0.00014	0.0002	0.00064	0.0008	0.0007	0.0008	0.001	0.0009	0.0007	0.0014	0.0011
		(0.3236)	(0.1555)	(1.0064)	(0.7801)	(1.4129)	***(1.7788)***	***(1.9105)***	***(2.1070)***	***(2.1976)***	(0.7948)	***(1.7582)***	***(2.3837)***
	Sell	0.00003	0.00001	-0.0004	-0.0004	-0.0008	-0.0006	-0.0006	-0.0006	-0.0008	-0.0003	-0.0009	-0.0007
		(0.7225)	(0.3936)	(0.5198)	(1.3533)	(1.6696)	***(1.7949)***	***(1.7871)***	***(1.7666)***	***(1.6460)***	(0.9037)	***(1.8358)***	***(2.2406)***
	Buy-Sell	0.00027	0.00013	0.0006	0.00104	0.0016	0.0013	0.0014	0.0016	0.0017	0.001	0.0023	0.0018
		(0.9015)	(0.4722)	(1.3102)	(1.8333)	(2.6379)	***(3.0353)***	***(3.1237)***	***(3.2464)***	***(3.2703)***	(1.4463)	***(3.0555)***	***(3.9290)***
(1,150,0.03)	N(Buy)	2190	1728	1553	2411	2096	1987	2008	2455	1748	1726	1483	2255
	N(Sell)	805	1068	1929	1261	1766	1513	1389	1488	1777	1338	1472	1597
	Buy	0.0003	0.0003	0.0002	0.00067	0.0009	0.0008	0.0008	0.0011	0.001	0.0008	0.0015	0.0012
		(0.2235)	(0.6304)	(0.9413)	(0.8248)	(1.6316)	***(1.9007)***	***(1.7891)***	***(2.3118)***	***(2.2886)***	(0.9201)	***(1.8136)***	***(2.5638)***

	Sell	-0.0003	-1E-05	-0.0006	-0.0004	-0.0008	-0.0007	-0.0007	-0.0007	-0.0009	-0.0006	-0.0009	-0.0008
		(1.4897)	(0.4040)	(0.7620)	(1.4358)	(1.6960)	***(2.1391)***	***(1.9054)***	***(1.9262)***	***(1.7568)***	(1.1656)	***(1.7295)***	***(2.1705)***
	Buy-Sell	0.0006	0.0003	0.0007	0.00107	0.0017	0.0015	0.0015	0.0018	0.0019	0.0014	0.0024	0.002
		(1.5190)	(0.8075)	(1.4126)	(1.9049)	(2.7924)	***(3.3440)***	***(3.0344)***	***(3.4965)***	***(3.3559)***	(1.7447)	***(2.9426)***	***(3.9307)***
(1,200,0)	N(Buy)	3241	2710	2008	2950	2417	2592	2820	2782	2319	2041	1792	2695
	N(Sell)	1255	1786	2488	1546	2079	1904	1676	1714	2177	1650	1899	1801
	Buy	0.00027	0.00015	0.0001	0.00056	0.0007	0.0004	0.0008	0.0009	0.0007	0.0007	0.0014	0.0008
		(0.2815)	(0.2022)	(0.8487)	(0.6067)	(1.3462)	(1.1193)	***(2.0024)***	***(1.8641)***	(1.8232)	(0.8216)	***(1.7125)***	***(1.6830)***
	Sell	-6E-05	-2.E-05	-0.0005	-0.0003	-0.0006	-0.0004	-0.0007	-0.0005	-0.0005	-0.0003	-0.0008	-0.0005
		(0.9664)	(0.5226)	(0.7944)	(1.2214)	(1.4791)	(1.5507)	***(1.9521)***	***(1.6480)***	(0.9691)	(0.8379)	***(1.7294)***	***(1.6675)***
	Buy-Sell	0.00033	0.00017	0.0006	0.00086	0.0013	0.0008	0.0015	0.0014	0.0012	0.001	0.0022	0.0013
		(1.1170)	(0.6368)	(1.4109)	(1.5946)	(2.4292)	(2.3032)	***(3.3475)***	***(2.9585)***	(2.3926)	(1.4217)	***(2.9543)***	***(2.8547)***
(1,200,0.005)	N(Buy)	3138	2591	1939	2912	2373	2512	2712	2741	2224	1989	1739	2635
	N(Sell)	1177	1663	2420	1507	2042	1827	1605	1684	2068	1605	1852	1743
	Buy	0.0003	0.00017	0.0002	0.0006	0.0008	0.0005	0.0008	0.0009	0.0008	0.0008	0.0014	0.0009
		(0.3015)	(0.3081)	(1.0084)	(0.7108)	(1.4683)	(1.0294)	***(1.9779)***	***(1.8554)***	(2.0288)	(0.8976)	***(1.7564)***	***(1.8873)***
	Sell	-0.0002	-3E-05	-0.0006	-0.0003	-0.0007	-0.0005	-0.0006	-0.0006	-0.0005	-0.0004	-0.0009	-0.0005
		(1.4971)	(0.5626)	(0.7548)	(1.2661)	(1.5185)	(1.6165)	***(1.7469)***	***(1.8568)***	(0.9522)	(0.9095)	***(1.8747)***	***(1.6581)***
	Buy-Sell	0.0005	0.0002	0.0008	0.0009	0.0015	0.001	0.0014	0.0015	0.0013	0.0012	0.0023	0.0014
		(1.6311)	(0.7509)	(1.5128)	(1.7095)	(2.5587)	(2.2772)	***(3.1185)***	***(3.1437)***	(2.5321)	(1.5414)	***(3.1021)***	***(2.9941)***
(1,200,0.01)	N(Buy)	3015	2464	1884	2862	2326	2413	2589	2694	2112	1941	1704	2581
	N(Sell)	1103	1535	2350	1474	2003	1737	1540	1644	1970	1556	1796	1702

	Buy	0.00025	0.00017	0.0003	0.0006	0.0007	0.0005	0.0009	0.0009	0.0008	0.0007	0.0015	0.0009
		(0.1510)	(0.3246)	(1.1482)	(0.7101)	(1.3838)	(1.2766)	***(2.2300)***	***(1.7355)***	(1.9933)	(0.8368)	***(1.8590)***	***(1.8747)***
	Sell	-0.0002	-8.E-05	-0.0005	-0.0004	-0.0007	-0.0004	-0.001	-0.0006	-0.0006	-0.0004	-0.001	-0.0006
		(1.2679)	(0.7421)	(0.8273)	(1.4552)	(1.5013)	(1.4417)	***(2.5948)***	***(1.8404)***	(1.1578)	(0.8999)	***(2.0133)***	***(1.8661)***
	Buy-Sell	0.00045	0.00025	0.0008	0.001	0.0014	0.0009	0.0019	0.0015	0.0014	0.0011	0.0025	0.0011
		(1.3056)	(0.9193)	(1.6885)	(1.8803)	(2.4652)	(2.3028)	***(4.0639)***	***(3.0253)***	(2.6594)	(1.4765)	***(3.2951)***	***(3.1619)***
(1,200,0.03)	N(Buy)	2390	1924	1632	2620	2143	2106	2185	2489	1767	1774	1517	2338
	N(Sell)	813	1066	2042	1274	1839	1462	1368	1448	1641	1353	1638	1535
	Buy	0.0002	-0.0017	0.0003	0.0007	0.0008	0.0007	0.001	0.0008	0.0009	0.0008	0.0017	0.001
		(0.1157)	(0.2803)	(1.1836)	(0.8659)	(1.4636)	(1.5679)	***(2.3737)***	***(1.6655)***	(2.0845)	(0.8920)	***(2.1534)***	***(2.0749)***
	Sell	-0.0002	-0.0015	-0.0006	-0.0004	-0.0007	-0.0006	-0.0008	-0.0007	-0.0006	-0.0003	-0.001	-0.0007
		(1.3637)	(0.2705)	(0.7151)	(1.3587)	(1.5185)	(1.8722)	***(2.1312)***	***(1.9704)***	(1.0838)	(0.7803)	***(1.9500)***	***(2.0706)***
	Buy-Sell	0.0004	-0.0002	0.0009	0.0011	0.0015	0.0013	0.0018	0.0015	0.0015	0.0011	0.0027	0.0017
		(1.2042)	(0.4391)	(1.5952)	(1.8747)	(2.5587)	(2.8549)	***(3.6820)***	***(3.0413)***	(2.6033)	(1.3902)	***(3.4410)***	***(3.4517)***
(2,200,0)	N(Buy)	3237	2703	2000	2946	2419	2595	2819	2780	2314	2045	1791	2694
	N(Sell)	1259	1793	2496	1550	2077	1901	1677	1716	2182	1646	1900	1802
	Buy	0.00028	0.00013	0.0002	0.00059	0.0007	0.0005	0.0007	0.0009	0.0007	0.0007	0.0013	0.0005
		(0.3210)	(0.1137)	(1.0138)	(0.6946)	(1.2992)	(1.0444)	***(1.7133)***	***(1.8637)***	***(1.8219)***	(0.8057)	(1.5892)	(0.7900)
	Sell	-8E-05	0.00001	-0.0006	-0.0003	-0.0006	-0.0003	-0.0006	-0.0005	-0.0008	-0.0002	-0.0005	-0.0004
		(1.0371)	(0.4048)	(0.9335)	(1.3526)	(1.4288)	(1.4614)	***(1.6416)***	***(1.7316)***	***(1.6589)***	(0.8221)	(1.2433)	(1.5047)
	Buy-Sell	0.00036	0.00012	0.0008	0.00089	0.0013	0.0008	0.0013	0.0014	0.0015	0.0009	0.0018	0.0009
		(1.2117)	(0.4591)	(1.6725)	(1.7829)	(2.3455)	(2.1621)	***(2.8379)***	***(3.0437)***	***(2.9909)***	(1.3945)	(2.4343)	(1.9975)

(2,200,0.005)	N(Buy)	3146	2592	1938	2902	2380	2511	2713	2737	2220	1988	1739	2645
	N(Sell)	1172	1662	2426	1505	2039	1824	1604	1680	2068	1595	1844	1747
	Buy	0.0003	0.0002	0.0003	0.00063	0.0007	0.0005	0.0007	0.0009	0.0007	0.0007	0.0013	0.0005
		(0.1826)	(0.4764)	(1.1662)	(0.7649)	(1.3403)	(1.1364)	***(1.6927)***	***(1.8546)***	(1.7966)	(0.8323)	(1.5623)	(0.8708)
	Sell	-0.0002	3.E-05	-0.0006	-0.0003	-0.0007	-0.0004	-0.0006	-0.0006	-0.0007	-0.0004	-0.0006	-0.0005
		(1.3808)	(0.3128)	(0.8828)	(1.3028)	(1.4854)	(1.4989)	***(1.6672)***	***(1.8551)***	(1.4031)	(0.9350)	(1.3072)	(1.6658)
	Buy-Sell	0.0005	0.00017	0.0009	0.00093	0.0014	0.0009	0.0013	0.0015	0.0014	0.0011	0.0019	0.001
		(1.4403)	(0.6550)	(1.7579)	(1.7834)	(2.4230)	(2.2574)	***(2.8268)***	***(3.1405)***	(2.7256)	(1.5095)	(2.4537)	(2.2008)
(2,200,0.01)	N(Buy)	3022	2461	1878	2861	2332	2406	2586	2701	2109	1939	1698	2575
	N(Sell)	1101	1536	2349	1470	2008	1737	1535	1638	1963	1549	1800	1707
	Buy	0.00023	0.00017	0.0002	0.00063	0.0007	0.0005	0.0008	0.0009	0.0007	0.0008	0.0013	0.0005
		(0.0686)	(0.3370)	(1.1161)	(0.7621)	(1.2977)	(1.1650)	***(1.9481)***	***(1.8468)***	***(1.7653)***	(0.9025)	(1.6606)	(0.9261)
	Sell	-0.0001	-1.E-05	-0.0005	-0.00031	-0.0007	-0.0004	-0.0007	-0.0006	-0.0009	-0.0004	-0.0006	-0.0005
		(1.1996)	(0.4227)	(0.9668)	(1.2552)	(1.5211)	(1.4579)	***(1.7910)***	***(1.8379)***	***(1.8205)***	(1.0127)	(1.3086)	(1.5280)
	Buy-Sell	0.00037	0.00018	0.0007	0.00093	0.0014	0.0009	0.0015	0.0015	0.0016	0.0012	0.0019	0.001
		(1.1865)	(0.6400)	(1.7337)	(1.7321)	(2.4120)	(2.2279)	***(3.1147)***	***(3.1081)***	***(3.0355)***	(1.6289)	(2.5303)	(2.1111)
(2,200,0.03)	N(Buy)	2392	1919	1636	2617	2144	2103	2178	2492	1766	1763	1516	2337
	N(Sell)	814	1068	2045	1277	1838	1455	1376	1437	1622	1356	1641	1537
	Buy	0.0002	0.0002	0.0004	0.00064	0.0008	0.0007	0.0009	0.001	0.0007	0.0007	0.0017	0.0006
		(0.0686)	(0.4224)	(1.4266)	(0.7845)	(1.4900)	(1.5419)	***(2.1056)***	***(2.0614)***	***(1.6577)***	(0.7633)	(2.1787)	(1.0345)
	Sell	-0.0001	-6E-05	-0.0005	-0.00033	-0.0007	-0.0006	-0.0008	-0.0006	-0.001	-0.0001	-0.0006	-0.0006
		(1.1996)	(0.5467)	(0.7171)	(1.2282)	(1.5269)	(1.7369)	***(1.9325)***	***(1.7494)***	***(1.9055)***	(0.5742)	(1.2822)	(1.8236)
	Buy-Sell	0.0003	0.00026	0.0009	0.00097	0.0015	0.0013	0.0017	0.0016	0.0017	0.0008	0.0023	0.0012

		(1.1865)	(0.7852)	(1.8075)	(1.6961)	(2.5432)	(2.7147)	***(3.3053)***	***(3.1344)***	***(2.9411)***	(1.1079)	(2.9111)	(2.4292)
(5,150,0)	N(Buy)	3117	2631	2031	2924	2468	2457	2604	2793	2196	2103	1887	2605
	N(Sell)	1429	1915	2515	1622	2078	2089	1942	1753	2350	1638	1854	1941
	Buy	0.00025	0.00012	0.0001	0.00052	0.0006	0.0006	0.0007	0.0006	0.0004	0.0007	0.001	0.0007
		(0.1867)	(0.0740)	(0.9447)	(0.4969)	(1.1289)	(1.3596)	***(1.6707)***	(1.1059)	(1.0995)	(0.8248)	(1.1205)	(1.2962)
	Sell	0.00001	0.00001	-0.0005	-0.00017	-0.0006	-0.0005	-0.0005	-0.0003	-0.0004	-0.0004	-0.0003	-0.0006
		(0.7621)	(0.3908)	(0.8539)	(1.0163)	(1.2987)	(1.7935)	***(1.6506)***	(1.1781)	(0.6984)	(0.9397)	(0.8553)	(2.0919)
	Buy-Sell	0.00024	0.00011	0.0006	0.00072	0.0012	0.0011	0.0012	0.0009	0.0008	0.0011	0.0013	0.0013
		(0.8557)	(0.4127)	(1.5482)	(1.3234)	(2.0919)	(2.7223)	***(2.8466)***	(1.9493)	(1.5522)	(1.5172)	(1.6992)	(2.9386)
(5,150,0.005)	N(Buy)	2961	2476	1967	2840	2413	2367	2527	2724	2114	2037	1803	2554
	N(Sell)	1302	1755	2433	1550	2020	2001	1865	1704	2237	1594	1789	1900
	Buy	0.0002	0.00014	0.0002	0.00051	0.0006	0.0006	0.0007	0.0006	0.0005	0.0006	0.0009	0.0007
		(0.0936)	(0.1891)	(1.0369)	(0.4699)	(1.0875)	(1.4403)	***(1.6546)***	(1.1471)	(1.3124)	(0.7357)	(0.9819)	(1.3329)
	Sell	-0.0001	-1E-05	-0.0005	-0.00024	-0.0006	-0.0005	-0.0006	-0.0004	-0.0004	-0.0004	-0.0002	-0.0007
		(0.9713)	(0.4922)	(0.9013)	(1.1460)	(1.4317)	(1.7966)	***(1.7779)***	(1.2791)	(0.6963)	(1.0353)	(0.8031)	(2.1285)
	Buy-Sell	0.0003	0.00015	0.0007	0.00075	0.0012	0.0011	0.0013	0.001	0.0009	0.001	0.0011	0.0014
		(0.9809)	(0.5918)	(1.6608)	(1.4167)	(2.1663)	(2.7748)	***(2.9311)***	(2.0656)	(1.7229)	(1.5223)	(1.5256)	(2.9919)
(5,150,0.01)	N(Buy)	2825	2324	1892	2751	2354	2309	2427	2658	2046	1976	1729	2491
	N(Sell)	1175	1599	2325	1479	1974	1895	1765	1647	2127	1546	1723	1855
	Buy	0.00024	0.00015	0.0003	0.00056	0.0006	0.0007	0.0008	0.0007	0.0005	0.0007	0.001	0.0008
		(0.1030)	(0.2247)	(1.1618)	(0.5903)	(1.1023)	(1.6170)	***(1.7705)***	(1.1787)	(1.2976)	(0.7309)	(1.1613)	(1.5877)
	Sell	0.00003	-7.E-05	-0.0005	-0.0003	-0.0007	-0.0004	-0.0006	-0.0004	-0.0004	-0.0004	-0.0006	-0.0006

		(0.6505)	(0.6678)	(0.8075)	(1.2126)	(1.4920)	(1.7602)	***(1.7429)***	(1.4644)	(0.7302)	(1.0024)	(1.3612)	(2.0874)
	Buy-Sell	0.00021	0.00022	0.0008	0.00086	0.0013	0.0011	0.0014	0.0011	0.0009	0.0011	0.0016	0.0014
		(0.6819)	(0.7704)	(1.6831)	(1.5609)	(2.2235)	(2.8713)	***(2.9704)***	(2.2496)	(1.7262)	(1.4822)	(2.1431)	(3.1497)
(5,150,0.03)	N(Buy)	2176	1717	1533	2390	2076	1984	1986	2429	1725	1731	1480	2250
	N(Sell)	811	1062	1912	1255	1745	1500	1364	1477	1775	1325	1457	1587
	Buy	0.0002	0.00015	0.0003	0.00058	0.0009	0.0007	0.0008	0.0007	0.0006	0.0007	0.0012	0.0008
		(0.0458)	(0.1873)	(0.9663)	(0.6232)	(1.5623)	(1.7391)	***(1.7822)***	(1.1912)	(1.4322)	(0.7158)	(1.3981)	(1.5349)
	Sell	-0.0001	-6E-05	-0.0006	-0.00033	-0.0006	-0.0005	-0.0007	-0.0005	-0.0006	-0.0005	-0.0004	-0.0007
		(0.6347)	(0.5610)	(0.9387)	(1.2372)	(1.3083)	(1.6162)	***(1.7662)***	(1.5503)	(1.0967)	(1.0506)	(1.0210)	(2.0451)
	Buy-Sell	0.0003	0.00021	0.0009	0.00091	0.0015	0.0012	0.0015	0.0012	0.0012	0.0012	0.0016	0.0015
		(0.6155)	(0.6236)	(1.5718)	(1.5769)	(2.3972)	(2.7619)	***(2.9013)***	(2.3039)	(2.0964)	(1.4820)	(2.0066)	(3.0119)
(5,200,0)	N(Buy)	3243	2701	1996	2946	2422	2579	2813	2781	2308	2053	1803	2694
	N(Sell)	1253	1795	2500	1550	2074	1917	1683	1715	2188	1638	1888	1802
	Buy	0.00027	0.00014	0.0001	0.00061	0.0008	0.0005	0.0005	0.0008	0.0001	0.0005	0.0013	0.0005
		(0.2548)	(0.1485)	(0.8920)	(0.7315)	(1.4323)	(1.0637)	(1.1731)	(1.4651)	(0.4159)	(0.5610)	(1.7001)	(0.7147)
	Sell	-4E-05	-1.E-05	-0.0005	-0.0004	-0.0007	-0.0004	-0.0006	-0.0005	-0.0004	-0.0001	-0.0006	-0.0004
		(0.9179)	(0.4500)	(0.8264)	(1.4088)	(1.5788)	(1.4717)	(1.6179)	(1.6400)	(0.7409)	(0.5432)	(1.3629)	(1.4064)
	Buy-Sell	0.00031	0.00013	0.0006	0.001	0.0015	0.0009	0.0011	0.0013	0.0004	0.0006	0.0019	0.0009
		(1.0523)	(0.5279)	(1.4756)	(1.8631)	(2.5889)	(2.1872)	(2.3990)	(2.6480)	(0.9970)	(0.9448)	(2.6316)	(1.8482)
(5,200,0.005)	N(Buy)	3149	2576	1935	2911	2383	2496	2699	2743	2215	2002	1739	2639
	N(Sell)	1173	1662	2427	1517	2027	1813	1616	1677	2069	1583	1833	1747
	Buy	0.0002	0.00016	0.0002	0.00062	0.0008	0.0005	0.0006	0.0008	0.0001	0.0006	0.0014	0.0005

		(0.0712)	(0.2467)	(0.9041)	(0.7364)	(1.4145)	(1.1904)	(1.4050)	(1.5859)	(0.4102)	(0.5874)	(1.7216)	(0.6905)
	Sell	-0.0001	-2E-05	-0.0005	-0.0004	-0.0007	-0.0003	-0.0006	-0.0006	-0.0004	-0.0002	-0.0005	-0.0005
		(1.0114)	(0.5054)	(0.8401)	(1.4533)	(1.5310)	(1.2546)	(1.7478)	(1.8539)	(0.7268)	(0.6271)	(1.3010)	(1.5319)
	Buy-Sell	0.0003	0.00018	0.0007	0.00102	0.0015	0.0008	0.0012	0.0014	0.0005	0.0008	0.0019	0.001
		(1.0131)	(0.6508)	(1.4905)	(1.9039)	(2.5240)	(2.0797)	(2.6815)	(2.9308)	(0.9730)	(1.0362)	(2.5844)	(1.9365)
(5,200,0.01)	N(Buy)	3014	2461	1863	2869	2337	2403	2592	2701	2100	1940	1691	2577
	N(Sell)	1096	1542	2349	1478	2000	1736	1533	1630	1967	1537	1796	1703
	Buy	0.00024	0.00018	0.0003	0.00062	0.0007	0.0004	0.0004	0.0009	0.0002	0.0006	0.0014	0.0006
		(0.1203)	(0.3310)	(1.0389)	(0.7480)	(1.3143)	(1.0997)	(0.9353)	***(1.8468)***	(0.6294)	(0.6362)	(1.7728)	(1.0683)
	Sell	-0.0001	-5.E-05	-0.0005	-0.0004	-0.0007	-0.0003	-0.0008	-0.0006	-0.0004	-0.0003	-0.0005	-0.0005
		(1.1515)	(0.6284)	(0.8892)	(1.3738)	(1.5357)	(1.2266)	(1.9245)	***(1.8345)***	(0.7141)	(0.7165)	(1.1744)	(1.6274)
	Buy-Sell	0.00037	0.00023	0.0008	0.001	0.0014	0.0007	0.0012	0.0015	0.0006	0.0009	0.0019	0.0011
		(1.1747)	(0.8214)	(1.6412)	(1.8333)	(2.4383)	(1.9694)	(2.4673)	***(3.1033)***	(1.1377)	(1.1498)	(2.5215)	(2.3127)
(5,200,0.03)	N(Buy)	2381	1914	1636	2620	2148	2101	2167	2490	1764	1759	1511	2344
	N(Sell)	812	1053	2039	1273	1843	1453	1367	1437	1617	1354	1638	1539
	Buy	0.0003	0.00018	0.0003	0.00065	0.0007	0.0005	0.0004	0.0008	0.0003	0.0007	0.0016	0.0006
		(0.1905)	(0.3231)	(1.2775)	(0.7938)	(1.3289)	(1.5100)	(0.8392)	(1.5583)	(0.8047)	(0.7316)	(1.9845)	(1.0356)
	Sell	-0.0001	-6E-05	-0.0005	-0.0004	-0.0007	-0.0005	-0.0009	-0.0006	-0.0005	-0.0002	-0.0005	-0.0006
		(1.0315)	(0.5591)	(0.6358)	(1.3583)	(1.5284)	(1.4945)	(2.2894)	(1.7494)	(0.8715)	(0.5686)	(1.1501)	(1.7717)
	Buy-Sell	0.0004	0.00024	0.0008	0.00105	0.0014	0.0011	0.0013	0.0014	0.0008	0.0009	0.0021	0.0012
		(1.0826)	(0.7252)	(1.6130)	(1.8227)	(2.4132)	(2.4764)	(2.6679)	(2.7579)	(1.3826)	(1.0776)	(2.6360)	(2.3843)

N(Buy) and N(Sell) are the number of buy and sell signals generated during the sample period, respectively. Numbers in parentheses are standard t-statistics using a two-tailed test. The Bond and Italic numbers of t-test values in the parentheses indicate the statistical significance at 1%, 5%, or 10% levels.

Appendix 2: Empirical results of the fixed-length moving average trading rules (FMA) with bands of 0%, 0.5%, 1%, and 3%

Appendix 2 shows the mean 10-day inflation adjusted returns generated by the FMA rules with bands of 0%, 0.5%, 1%, and 3%. The number of buy and sell signals generated by the FMA trading rules is far fewer than the VMA trading rules. Similar to the VMA rules, the FMA rules without a band generate the highest number of signals; rules with bands of 0.5%, 1%, and 3% are ranked second, third and fourth, respectively. For most of the FMA rules, the technical trading returns are larger for trading rules with a higher band. In addition, the FMA rules with band of 0.5% generate similar number of signals and the mean 10-day returns with a band of 1% rule. The FMA rules with a band of 3% generate small signals, which are on average, two times smaller than the FMA rules with bands of 0.5% and 1%. The FMA rules with a band of 3% filter out too many signals. For the large long term moving average period, such as 200 days, the 3% band FMA rules can only detect the number of signals around 10 for the whole sample period. Despite the 3% band, FMA rules can generate the highest returns; it filters out many buy and sell signals that may have more useful information. Therefore, consistent with previous studies (Brock et al., 1992; Bessembinder and Chan 1995, 1998), this study considers a one percent band is more appropriate to filter out false signals generated by the FMA rules.

Appendix 2: Empirical results of the fixed-length moving average trading rules (FMA) with bands of 0%, 0.5%, 1%, and 3%

FMA rules adjusted for inflation													
		Developed Stock Markets						Emerging Stock Markets					
		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns		0.23%	0.10%	-0.24%	0.36%	0.26%	0.16%	0.21%	0.30%	0.07%	0.46%	0.47%	0.26%
Rules													
(1,50,0)	N(Buy)	51	58	66	48	54	57	47	40	49	37	38	51
	N(Sell)	59	68	63	63	60	55	54	44	57	42	45	55
	Buy	0.0003	-0.0019	-0.0017	-2E-05	0.0089	0.0015	0.0055	0.0199	0.009	0.0202	0.0145	0.0042
		(0.0540)	(1.7779)	(0.8078)	(0.1289)	***(3.4231)***	(0.7854)	(2.5244)	***(8.0493)***	***(3.7633)***	***(5.5530)***	***(3.9482)***	***(1.8700)***
	Sell	-0.001	0.0012	0.0026	0.0019	-0.0048	-0.0024	0.0021	-0.0176	-0.0088	-0.0056	-0.0056	-0.0074
		(1.0490)	(1.0172)	(1.4838)	(0.7521)	***(2.0007)***	(1.4301)	(0.9923)	***(7.6172)***	***(3.9032)***	***(1.7252)***	***(1.7671)***	***(3.7038)***
	Buy-Sell	0.0013	-0.0031	-0.0043	-0.0019	0.0137	0.0039	0.0034	0.0375	0.0178	0.0258	0.0201	0.0116
		(0.7585)	(2.0092)	(1.6369)	(0.5954)	***(3.8833)***	(1.5799)	(1.1743)	***(11.1322)***	***(5.4438)***	***(5.2552)***	***(4.1238)***	***(3.9383)***
(1,50,0.005)	N(Buy)	45	50	55	44	47	49	40	38	47	35	38	48
	N(Sell)	47	54	50	49	54	43	42	43	50	39	39	46
	Buy	0.0013	-0.0015	0.0028	0.0033	0.014	0.0019	0.0012	0.0219	0.0084	0.0147	0.0153	0.0052
		(0.8353)	(1.3083)	(1.4840)	(1.1676)	***(5.0586)***	(0.9419)	(0.4928)	***(8.6493)***	***(3.4578)***	***(3.9100)***	***(4.1597)***	***(2.2676)***
	Sell	-0.0015	-0.0068	-0.0023	0.0004	-0.0067	-0.0021	-0.0009	-0.0190	-0.0117	-0.0057	-0.0058	-0.0077
		(1.3138)	(5.8486)	(0.9823)	(0.0320)	***(2.6425)***	(1.1147)	(0.4576)	***(8.1173)***	***(4.8695)***	***(1.6916)***	***(1.7024)***	***(3.5105)***
	Buy-Sell	0.0028	0.0053	0.0051	0.0029	0.0207	0.004	0.0021	0.0409	0.0201	0.0204	0.0211	0.0129
		(1.5233)	(3.1307)	(1.7448)	(0.8293)	***(5.5302)***	(1.4645)	(0.6752)	***(11.9125)***	***(5.9025)***	***(4.0204)***	***(4.1767)***	***(4.1152)***

(1,50,0.01)	N(Buy)	34	45	52	38	44	39	34	34	43	35	35	42
	N(Sell)	42	42	46	46	45	41	37	38	42	36	36	41
	Buy	0.0016	-0.0012	0.003	0.0037	0.011	0.0026	-0.0009	0.0231	0.0051	0.0155	0.0208	0.0061
		(0.9118)	(1.0440)	(1.5564)	(1.2270)	***(3.8268)***	(1.1634)	(0.3957)	***(8.6431)***	***(2.0218)***	***(4.1204)***	***(5.4509)***	***(2.4940)***
	Sell	-0.0018	-0.0074	-0.0029	0.0001	-0.0106	-0.0022	-0.0011	-0.0157	-0.0158	-0.006	-0.0061	-0.0077
		(1.4746)	(5.6231)	(1.1980)	(0.0892)	***(3.8104)***	(1.1157)	(0.5062)	***(6.3245)***	***(6.0423)***	***(1.7080)***	***(1.7171)***	***(3.3160)***
	Buy-Sell	0.0034	0.0062	0.0059	0.0036	0.0216	0.0048	0.0002	0.0388	0.0209	0.0215	0.0269	0.0138
		(1.6710)	(3.3333)	(1.9491)	(0.9719)	***(5.4257)***	(1.6187)	(0.0650)	***(10.6662)***	***(5.7445)***	***(4.1519)***	***(5.1099)***	***(4.1298)***
(1,50,0.03)	N(Buy)	17	23	30	28	31	22	20	29	27	27	28	27
	N(Sell)	22	21	32	33	31	23	23	30	30	27	28	26
	Buy	0.009	0.0064	0.0124	0.0079	0.0168	0.0050	0.0159	0.0157	0.0231	0.0159	0.0263	0.0149
		(4.0249)	(3.5118)	***(4.6129)***	(2.3623)	***(4.9441)***	(1.7546)	(4.8560)	***(5.3809)***	***(7.1299)***	***(3.7193)***	***(6.1995)***	***(5.0159)***
	Sell	-0.0026	-0.0025	-0.0085	0.0029	-0.0119	-0.0074	0.0002	-0.0156	-0.0171	-0.007	-0.0079	-0.0103
		(1.4699)	(1.3806)	***(3.1188)***	(0.8601)	***(3.5526)***	(2.7686)	(0.0351)	***(5.6023)***	***(5.5299)***	***(1.7164)***	***(1.9496)***	***(3.5150)***
	Buy-Sell	0.0116	0.0089	0.0209	0.005	0.0287	0.0124	0.0157	0.0313	0.0402	0.0229	0.0342	0.0252
		(4.0012)	(3.4325)	***(5.5014)***	(1.1579)	***(6.0278)***	(3.1979)	(3.5350)	***(7.7890)***	***(9.0055)***	***(3.8569)***	***(5.7830)***	***(6.0390)***
(1,150,0)	N(Buy)	29	34	32	27	23	30	29	23	36	21	27	22
	N(Sell)	39	32	27	33	27	24	25	29	35	30	28	29
	Buy	0.0034	-0.0028	-0.0053	0.0018	0.007	0.0013	0.0047	0.0065	0.0059	-0.0055	0.02	0.017
		(1.9080)	(1.9713)	(1.9158)	(0.4363)	***(1.7676)***	(0.4879)	***(1.7001)***	***(1.9518)***	***(2.1188)***	(1.1952)	***(4.6169)***	(5.1764)
	Sell	0.0004	-0.0026	0.0012	-0.0026	-0.0163	-0.0007	-0.0057	-0.0110	-0.0059	0.0141	-0.0102	-0.0014
		(0.1074)	(1.7467)	(0.4970)	(1.0049)	***(4.5131)***	(0.2970)	***(2.0053)***	***(3.9127)***	***(2.0321)***	(3.4692)	***(2.4955)***	(0.5604)

	Buy-Sell	0.003	-0.0002	-0.0065	0.0044	0.0233	0.002	0.0104	0.0175	0.0118	-0.0196	0.0302	0.0184
		(1.3790)	(0.1197)	(1.6674)	(1.0009)	***(4.3718)***	(0.5482)	***(2.6338)***	***(4.0714)***	***(2.9456)***	(3.1539)	***(5.0614)***	(4.2817)
(1,150,0.005)	N(Buy)	21	24	24	20	20	24	22	23	32	20	23	20
	N(Sell)	32	27	24	32	22	21	25	26	32	24	26	25
	Buy	0.0035	-0.0009	-0.0001	0.0024	0.0172	0.0044	0.0063	0.0066	0.006	-0.0041	0.0277	0.0176
		(1.6760)	(0.5690)	(0.0585)	(0.5506)	***(4.0670)***	***(1.5958)***	***(2.0098)***	***(2.0139)***	***(2.0525)***	(0.8816)	***(5.9207)***	(5.1124)
	Sell	0.003	-0.0027	-0.0099	-0.0002	-0.011	-0.0047	-0.0078	-0.0091	-0.0059	0.0102	-0.0098	-0.0041
		(1.7520)	(1.6846)	(3.1650)	(0.1750)	***(2.7609)***	***(1.6903)***	***(2.7013)***	***(3.0858)***	***(1.9531)***	(2.2405)	***(2.3010)***	(1.4028)
	Buy-Sell	0.0005	0.0018	0.0099	0.0026	0.0282	0.0091	0.0141	0.0158	0.0119	-0.0143	0.0375	0.0217
		(0.1987)	(0.7438)	(2.2852)	(0.5418)	***(4.8594)***	***(2.3300)***	***(3.3222)***	***(3.5906)***	***(2.8420)***	(2.1679)	***(2.9072)***	(4.7563)
(1,150,0.01)	N(Buy)	19	21	23	19	18	20	20	19	25	17	20	19
	N(Sell)	22	23	21	24	20	20	21	25	31	20	24	20
	Buy	0.0035	-0.0008	-0.0006	0.0027	0.015	0.0056	0.0093	0.007	0.0077	0.0031	0.0236	0.0169
		(1.5917)	(0.5038)	(0.1170)	(0.6067)	***(3.3688)***	***(1.8762)***	***(2.8168)***	***(1.9159)***	***(2.3157)***	(0.5336)	***(4.7019)***	***(4.7838)***
	Sell	0.0026	-0.0036	-0.0129	0.0015	-0.0091	-0.0048	-0.0060	-0.0083	-0.0061	0.0078	-0.0107	-0.0155
		(1.2221)	(2.0690)	(3.8901)	(0.3440)	***(2.1784)***	***(1.6883)***	***(1.9220)***	***(2.7527)***	***(1.9885)***	(1.5531)	***(2.4176)***	***(4.5994)***
	Buy-Sell	0.0009	0.0028	0.0123	0.0012	0.0241	0.0104	0.0153	0.0153	0.0138	-0.0047	0.0343	0.0324
		(0.3344)	(1.0679)	(2.7378)	(0.2249)	***(3.9512)***	***(2.5259)***	***(3.3655)***	***(3.2526)***	***(3.0605)***	(0.6623)	***(5.1165)***	***(6.6498)***
(1,150,0.03)	N(Buy)	10	15	14	10	15	12	13	17	18	12	15	13
	N(Sell)	14	17	15	14	16	16	18	18	20	17	16	17
	Buy	0.0059	0.0015	0.0086	0.0133	0.0157	0.0102	0.0089	0.0072	0.0075	0.0033	0.0303	0.0268
		(1.9990)	(0.6256)	(2.1948)	(2.4404)	***(3.2193)***	(2.6601)	***(2.1849)***	***(1.8661)***	***(1.9060)***	(0.4837)	***(5.2370)***	***(6.3126)***

	Sell	-0.0058	-0.0085	-0.0057	-0.022	-0.015	-0.0051	-0.0081	-0.008	-0.0069	-0.0018	-0.01	-0.0165
		(2.4993)	(4.0893)	(1.4171)	(4.9510)	***(3.2164)***	(1.5984)	***(2.3920)***	***(2.2500)***	***(1.8115)***	(0.3804)	***(1.8499)***	***(4.5326)***
	Buy-Sell	0.0117	0.01	0.0143	0.0353	0.0307	0.0153	0.0170	0.0152	0.0144	0.0021	0.0403	0.0433
		(3.1441)	(3.2616)	(2.5670)	(5.0664)	***(4.5576)***	(3.0616)	***(3.2192)***	***(2.9117)***	***(2.6349)***	(0.6161)	***(5.0591)***	***(7.7477)***
(1,200,0)	N(Buy)	22	33	28	21	16	28	18	21	35	18	21	22
	N(Sell)	28	31	21	23	21	23	26	24	38	24	16	27
	Buy	0.0054	-0.0026	0.0002	-0.0058	0.0369	0.0014	0.0102	0.0061	-0.0009	-0.0038	-0.0022	0.0213
		(2.6828)	(1.8228)	(0.1398)	(1.6738)	***(7.8401)***	(0.5112)	***(2.9387)***	***(1.7468)***	(0.2883)	(0.7894)	(0.5181)	(6.4945)
	Sell	0.0005	-0.0094	-0.0139	-0.0142	-0.0168	-0.0002	-0.0088	-0.0051	-0.0046	-0.005	-0.0135	-0.0007
		(0.1677)	(6.0931)	(4.1725)	(4.1157)	***(4.1085)***	(0.1240)	***(3.1174)***	***(1.6846)***	(1.6638)	(1.1775)	(2.4705)	(0.3077)
	Buy-Sell	0.0049	0.0068	0.0141	0.0083	0.0537	0.0016	0.0190	0.0112	0.0037	0.0012	0.0113	0.022
		(1.9007)	(3.1166)	(3.2529)	(1.6374)	***(8.6243)***	(0.4365)	***(4.2628)***	***(2.4322)***	(0.9479)	(0.1751)	(1.5234)	(5.0390)
(1,200,0.005)	N(Buy)	17	23	24	18	16	26	17	19	30	17	19	16
	N(Sell)	22	25	18	18	20	20	21	22	36	20	14	20
	Buy	0.0042	0.003	-0.0001	0.0032	0.0303	0.0018	0.0095	0.0066	-0.0006	-0.0046	0.0019	0.0145
		(1.8182)	(1.6100)	(0.0563)	(0.7237)	***(6.4244)***	(0.6489)	***(2.6606)***	***(1.8030)***	(0.1582)	(0.9215)	(0.3213)	(3.7621)
	Sell	0.0029	-0.0063	-0.0061	-0.0079	-0.0127	-0.0004	-0.0090	-0.0055	-0.0044	-0.0028	-0.0104	-0.0009
		(1.4020)	(3.7026)	(1.6630)	(2.0384)	***(3.0467)***	(0.1817)	***(2.8661)***	***(1.7347)***	(1.5393)	(0.6130)	(1.7917)	(0.3237)
	Buy-Sell	0.0013	0.0093	0.006	0.011	0.043	0.0022	0.0185	0.0121	0.0038	-0.0018	0.0123	0.0154
		(0.4403)	(3.7317)	(1.2965)	(1.9568)	***(6.8321)***	(0.5659)	***(3.9027)***	***(2.5070)***	(0.9245)	(0.2624)	(1.5717)	(3.0252)
(1,200,0.01)	N(Buy)	13	20	20	13	14	19	14	17	28	16	18	13
	N(Sell)	17	19	18	16	20	23	18	20	32	16	13	18

	Buy	0.0087	0.0035	0.004	0.0079	0.0377	0.0023	0.0093	0.0068	-0.0016	-0.0012	0.0041	0.0185
		(3.4246)	***(1.7640)***	(1.2631)	(1.6217)	***(7.4934)***	(0.7215)	***(2.3645)***	***(1.7592)***	(0.4707)	(0.2673)	(0.7286)	(4.3281)
	Sell	0.008	-0.0069	-0.0036	-0.0056	-0.0126	-0.0003	-0.0108	-0.0062	-0.0061	-0.0053	-0.0052	-0.0012
		(3.5841)	***(3.5481)***	(0.9536)	(1.4047)	***(3.0245)***	(0.1581)	***(3.1790)***	***(1.8570)***	(2.0040)	(1.0116)	(0.8929)	(0.3908)
	Buy-Sell	0.0007	0.0104	0.0076	0.0135	0.0503	0.0026	0.0201	0.013	0.0045	0.0041	0.0093	0.0197
		(0.2179)	***(3.7798)***	(1.5643)	(2.1484)	***(7.7007)***	(0.6416)	***(4.2628)***	***(2.5572)***	(1.0289)	(0.5274)	(1.1544)	(3.5562)
(1,200,0.03)	N(Buy)	7	10	10	9	12	10	8	12	20	13	11	10
	N(Sell)	14	14	10	10	13	13	13	13	18	13	10	15
	Buy	0.0036	0.002	0.0033	0.0178	0.0189	0.0078	0.0178	0.0076	-0.001	-0.001	0.0038	0.025
		(0.9881)	(0.6816)	(0.7513)	(3.1163)	***(3.4705)***	(1.8610)	***(3.4463)***	***(1.6584)***	(0.2449)	(0.2041)	(0.5232)	(5.1612)
	Sell	0.0144	-0.0028	0.0018	-0.004	-0.0159	-0.0007	-0.0106	-0.0193	-0.0024	-0.0054	-0.0061	-0.0017
		(5.9263)	(1.2580)	(0.4342)	(0.8199)	***(3.0691)***	(0.2292)	***(2.6535)***	***(4.5687)***	(0.5947)	(0.9304)	(0.9080)	(0.4841)
	Buy-Sell	-0.0109	0.0048	0.0015	0.0218	0.0348	0.0085	0.0284	0.0269	0.0014	0.0044	0.0099	0.0267
		(2.6192)	(1.3344)	(0.2245)	(2.8278)	***(4.6351)***	(1.5519)	***(4.3540)***	***(4.3671)***	(0.2634)	(0.5144)	(1.0195)	(4.3088)
(2,200,0)	N(Buy)	19	27	25	17	16	27	18	20	35	17	20	20
	N(Sell)	27	29	20	19	20	23	24	23	37	22	18	24
	Buy	0.0034	-0.0014	-0.0029	0.0079	0.0343	0.0009	0.0117	0.003	-0.0015	-0.0064	-0.0028	0.0167
		(1.5302)	(0.8947)	(0.8935)	***(1.8419)***	***(7.2841)***	(0.3044)	(3.3897)	(0.7916)	(0.5074)	(1.2585)	(0.6156)	(4.8331)
	Sell	0.0068	-0.0085	-0.0059	-0.0227	-0.0164	-0.0018	0.0053	-0.0145	-0.0071	-0.0054	-0.0264	0.0026
		(3.7892)	(5.3651)	(1.6974)	***(5.9386)***	***(3.9192)***	(0.7072)	(1.7305)	(4.5812)	(2.5242)	(1.2170)	(5.0852)	(0.7576)
	Buy-Sell	-0.0034	0.0071	0.003	0.0305	0.0507	0.0027	0.0064	0.0175	0.0056	-0.001	0.0236	0.0141
		(1.2676)	(3.0911)	(0.6706)	***(5.4297)***	***(8.0568)***	(0.7280)	(1.4315)	(3.7122)	(1.4018)	(0.1415)	(3.2729)	(3.0648)

(2,200,0.005)	N(Buy)	17	23	20	14	15	23	17	17	29	16	19	16
	N(Sell)	20	22	19	15	20	21	20	20	33	17	14	19
	Buy	0.0066	-0.0026	-0.0049	0.0013	0.0297	0.0009	0.0086	0.0022	-0.0004	-0.0035	-0.0005	0.0193
		(2.9322)	(1.5248)	(1.3989)	(0.2148)	***(6.1074)***	(0.2811)	(2.4071)	(0.5315)	(0.1030)	(0.6776)	(0.1517)	(5.0196)
	Sell	0.0011	-0.0049	-0.0055	-0.0277	-0.0196	-0.002	0.0011	-0.0155	-0.0024	-0.0044	-0.007	0.0004
		(0.4407)	(2.6915)	(1.5381)	(6.4380)	***(4.6732)***	(0.7458)	(0.3050)	(4.5372)	(0.7910)	(0.8837)	(1.2254)	(0.0502)
	Buy-Sell	0.0055	0.0023	0.0006	0.029	0.0493	0.0029	0.0075	0.0177	0.002	0.0009	0.0065	0.0189
		(1.8604)	(0.8600)	(0.1252)	(4.6350)	***(7.6900)***	(0.7351)	(1.5657)	(3.4735)	(0.4675)	(0.1294)	(0.8325)	(3.6707)
(2,200,0.01)	N(Buy)	13	20	19	12	14	18	14	16	27	16	17	13
	N(Sell)	16	18	16	14	19	21	18	18	30	14	12	17
	Buy	0.0072	-0.0002	-0.0048	0.0014	0.0351	0.0011	0.0070	-0.0015	-0.0005	-0.0088	0.00004	0.0231
		(2.8222)	(0.1774)	(1.3365)	(0.2285)	***(6.9797)***	(0.3136)	(1.7753)	(0.4509)	(0.1295)	(1.6452)	(0.0435)	(5.4175)
	Sell	0.0007	-0.0088	-0.0049	-0.0288	-0.0169	-0.0014	-0.0013	-0.0151	-0.0026	-0.0056	-0.0079	0.0018
		(0.2270)	(4.3644)	(1.2496)	(6.4661)	***(3.9500)***	(0.5513)	(0.4219)	(4.2213)	(0.8051)	(0.9911)	(1.2810)	(0.4326)
	Buy-Sell	0.0065	0.0086	0.0001	0.0302	0.052	0.0025	0.0083	0.0136	0.0021	-0.0032	0.008	0.0213
		(1.9470)	(3.0499)	(0.0168)	(4.5673)	***(7.8820)***	(0.6059)	(1.6130)	(2.5727)	(0.4643)	(0.4011)	(0.9543)	(3.7982)
(2,200,0.03)	N(Buy)	8	9	10	8	12	9	8	12	18	10	10	10
	N(Sell)	13	13	10	8	13	12	12	13	18	12	9	15
	Buy	0.0071	0.0003	0.0003	0.0221	0.0129	0.0057	0.0166	-0.0002	0.0011	-0.0305	-0.0021	0.0123
		(2.1857)	(0.0720)	(0.1167)	(3.6568)	***(2.3587)***	(1.2858)	(3.2040)	(0.970)	(0.3034)	(4.4529)	(0.3413)	(2.5087)
	Sell	0.0136	-0.0088	0.001	-0.007	-0.0172	-0.0023	-0.0040	-0.0115	-0.0026	0.0008	-0.006	-0.0032
		(5.3742)	(3.7169)	(0.2649)	(1.2319)	***(2.3187)***	(0.6437)	(0.9822)	(2.7304)	(0.6355)	(0.0877)	(0.8466)	(0.8625)
	Buy-Sell	-0.0065	0.0091	-0.0007	0.0291	0.0301	0.008	0.0206	0.0113	0.0037	-0.0313	0.0039	0.0155

		(1.6005)	(2.4360)	(0.1049)	(3.4598)	***(4.0055)***	(1.3949)	(3.1059)	(1.8243)	(0.6652)	(3.3521)	(0.3797)	(2.4917)
(5,150,0)	N(Buy)	24	25	22	21	19	22	23	20	29	18	24	18
	N(Sell)	29	27	23	23	20	21	22	25	31	18	22	23
	Buy	0.0031	-0.0026	0.0058	-0.0002	0.0158	0.0072	0.0074	0.0048	0.0102	-0.0067	0.0091	0.0272
		(1.5988)	(1.5643)	(1.8716)	(0.1464)	***(3.6420)***	(2.5347)	***(2.33910)***	(1.3052)	***(3.2838)***	(1.3492)	(1.9365)	***(7.5210)***
	Sell	0.003	-0.004	-0.0093	-0.019	-0.018	-0.0012	-0.0104	-0.0022	-0.0053	-0.0038	0.0014	-0.0052
		(1.6518)	(2.4912)	(2.9199)	(5.4899)	***(4.2962)***	(0.4829)	***(3.3766)***	(0.7995)	***(1.7243)***	(0.7846)	(0.2283)	***(1.7011)***
	Buy-Sell	0.0001	0.0014	0.0151	0.0188	0.0338	0.0084	0.0178	0.007	0.0155	-0.0029	0.0077	0.0324
		(0.0707)	(0.6022)	(3.3878)	(3.6959)	***(5.6184)***	(2.1217)	***(4.0955)***	(1.5093)	***(3.5705)***	(0.4001)	(1.1779)	***(6.7738)***
(5,150,0.005)	N(Buy)	19	21	21	17	17	18	21	19	22	16	21	18
	N(Sell)	23	22	18	20	18	18	21	22	30	15	18	21
	Buy	0.0019	-0.0013	0.0064	-0.0043	0.0101	0.0105	0.0101	0.0141	0.0148	-0.0044	0.0094	0.0227
		(0.8211)	(0.7445)	(2.0095)	(1.1294)	***(2.1982)***	(3.3589)	***(3.1507)***	(3.9062)	***(4.1287)***	(0.8534)	(1.8796)	***(6.2804)***
	Sell	0.0045	-0.0051	-0.0159	-0.0066	-0.0168	0.008	-0.0150	-0.0039	-0.0054	-0.0043	0.0117	-0.0063
		(2.2768)	(2.8383)	(4.4320)	(1.8402)	***(3.8014)***	(2.5490)	***(4.7544)***	(1.2568)	***(1.7290)***	(0.8019)	(2.1892)	***(1.9597)***
	Buy-Sell	-0.0026	0.0038	0.0223	0.0023	0.0269	0.0025	0.0251	0.018	0.0202	-0.0001	-0.0023	0.029
		(0.9262)	(1.4545)	(4.6266)	(0.4182)	***(4.2337)***	(0.5738)	***(5.6022)***	(3.7247)	***(4.2715)***	(0.0176)	(0.3298)	***(5.9517)***
(5,150,0.01)	N(Buy)	16	20	18	17	14	15	19	16	19	14	17	17
	N(Sell)	18	20	18	16	16	17	19	19	26	15	17	19
	Buy	-0.003	-0.0012	0.0053	-0.0032	0.0144	0.0111	0.0152	0.0226	0.0172	-0.0116	0.0137	0.0207
		(1.3393)	(0.6725)	(1.5517)	(0.8549)	***(2.8472)***	(3.2438)	***(4.5076)***	(5.7846)	***(4.4725)***	(2.0255)	(2.4873)	***(5.5602)***
	Sell	0.0046	-0.0036	-0.0175	-0.0054	-0.0147	0.008	-0.0168	-0.0026	-0.006	-0.0133	0.0179	-0.0103

		(2.0756)	(1.9206)	(4.9045)	(1.3695)	***(3.1486)***	(2.4826)	***(2.0623)***	(0.7976)	***(1.7918)***	(2.3984)	(3.2652)	***(2.9985)***
	Buy-Sell	-0.0074	0.0024	0.0228	0.0022	0.0291	0.0031	0.0320	0.0252	0.0232	0.0017	-0.0042	0.031
		(2.4028)	(0.8844)	(4.5739)	(0.3883)	***(4.2370)***	(0.6653)	***(6.7806)***	(4.8096)	***(4.5740)***	(0.2103)	(0.5513)	***(6.1114)***
(5,150,0.03)	N(Buy)	8	13	12	9	11	10	11	15	17	11	12	14
	N(Sell)	13	16	11	11	15	15	18	15	18	12	13	14
	Buy	0.007	-0.0008	-0.0075	0.0183	0.0361	0.01	0.0260	0.0151	0.0115	-0.0323	0.0135	0.0365
		(2.1332)	(0.3775)	(1.6889)	(3.2074)	***(6.3561)***	(2.3859)	***(5.9001)***	(3.7320)	***(2.8371)***	(4.9469)	(2.0583)	***(8.9288)***
	Sell	0.0087	-0.0033	-0.0033	-0.0102	-0.0148	0.0037	-0.0170	-0.0028	-0.0198	-0.0227	-0.0011	-0.0172
		(3.4146)	(1.5761)	(0.6827)	(2.0779)	***(3.0693)***	(1.0533)	***(4.9861)***	(0.7672)	***(4.9676)***	(3.6402)	(0.2269)	***(4.2867)***
	Buy-Sell	-0.0017	0.0025	-0.0042	0.0285	0.0509	0.0063	0.0430	0.0179	0.0313	-0.0096	0.0146	0.0537
		(0.4306)	(0.7762)	(0.6758)	(3.7765)	***(6.8330)***	(1.1828)	***(7.7305)***	(3.1865)	***(5.5069)***	(1.0566)	(1.6440)	***(9.3587)***
(5,200,0)	N(Buy)	17	23	20	14	15	27	18	17	31	17	19	19
	N(Sell)	22	26	21	14	19	20	19	16	33	17	13	19
	Buy	0.0048	0.0014	0.0032	-0.0011	0.035	0.0003	0.0099	-0.0044	0.0053	-0.0159	0.0008	0.0229
		(2.1021)	(0.7316)	(1.0040)	(0.3175)	***(7.1980)***	(0.0666)	***(2.8585)***	(1.2449)	***(1.7920)***	(3.0480)	(0.1050)	***(6.4958)***
	Sell	0.0001	-0.0073	-0.0043	-0.0247	-0.0121	-0.0016	-0.0055	-0.0222	-0.0049	-0.0084	-0.0141	-0.013
		(0.0671)	(4.3896)	(1.2477)	(5.5457)	***(2.8177)***	(0.5997)	***(1.6788)***	(0.1756)	***(1.6425)***	(1.6209)	(2.3302)	***(3.7872)***
	Buy-Sell	0.0047	0.0087	0.0075	0.0236	0.0471	0.0019	0.0154	0.0178	0.0103	-0.0076	0.0149	0.0359
		(1.6261)	(3.5499)	(1.5934)	(3.7024)	***(7.2647)***	(0.4991)	***(3.2257)***	(3.3209)	***(2.4382)***	(1.0113)	(1.8656)	***(7.2859)***
(5,200,0.005)	N(Buy)	13	22	19	12	14	19	16	15	27	15	17	15
	N(Sell)	17	19	18	13	18	18	17	16	32	15	13	17
	Buy	0.0065	-0.0032	-0.0019	0.0126	0.0319	0.0008	0.0109	-0.0025	0.0095	-0.0215	-0.0014	0.0159

		(2.5363)	(1.7966)	(0.4985)	***(2.5209)***	(6.3321)	(0.2223)	***(2.9665)***	(0.6928)	***(2.9607)***	(3.8456)	(0.3105)	***(4.0003)***
	Sell	-0.0042	-0.0125	-0.0037	-0.0353	-0.013	-0.0014	-0.0071	-0.0207	-0.005	-0.0011	-0.0031	-0.0065
		(2.0276)	(6.3429)	(0.9928)	***(7.6201)***	(2.9504)	(0.4963)	***(2.0416)***	(5.4212)	***(1.6512)***	(0.2423)	(0.5477)	***(1.8156)***
	Buy-Sell	0.0107	0.0093	0.0018	0.0479	0.0449	0.0022	0.0180	0.0182	0.0145	-0.0203	0.0017	0.0224
		(3.2490)	(3.4298)	(0.3644)	***(7.1068)***	(6.7114)	(0.5117)	***(3.5570)***	(3.2790)	***(3.3075)***	(2.5528)	(0.2081)	***(4.1656)***
(5,200,0.01)	N(Buy)	12	18	16	11	14	16	12	14	22	14	17	11
	N(Sell)	16	17	13	9	15	17	16	16	29	13	10	17
	Buy	0.0069	-0.0029	-0.0064	0.0128	0.0345	0.001	0.0121	0.0021	0.013	-0.0236	-0.0013	0.0298
		(2.5823)	(1.4509)	(1.6591)	***(2.4550)***	(6.8543)	(0.2652)	***(2.8542)***	(0.4540)	***(3.6506)***	(4.0810)	(0.2906)	***(6.4508)***
	Sell	-0.0044	-0.0087	0.001	-0.0388	-0.0073	-0.0017	-0.0074	-0.0091	-0.0064	-0.0093	-0.0034	-0.0066
		(2.0585)	(4.2059)	(0.3012)	***(6.9715)***	(1.5225)	(0.5769)	***(2.0678)***	(2.4350)	***(2.0320)***	(1.5780)	(0.5195)	***(1.8427)***
	Buy-Sell	0.0113	0.0058	-0.0074	0.0516	0.0418	0.0027	0.0195	0.0112	0.0194	-0.0143	0.0021	0.0364
		(3.3045)	(2.0085)	(1.3367)	***(6.8239)***	(5.9965)	(0.5930)	***(3.5162)***	(1.9983)	***(4.0980)***	(1.6986)	(0.2355)	***(6.1893)***
(5,200,0.03)	N(Buy)	8	9	10	6	11	8	8	11	16	10	10	10
	N(Sell)	11	13	9	8	12	10	10	12	19	11	9	13
	Buy	0.007	-0.0057	-0.0013	0.0324	0.0174	0.001	0.0164	0.0025	0.0059	-0.0119	0.0164	0.0235
		(2.1396)	(2.0186)	(0.2404)	(4.6618)	(3.0597)	(0.1796)	***(3.1733)***	(0.4917)	***(3.7962)***	(1.7624)	(2.2983)	***(4.8442)***
	Sell	-0.0048	-0.0107	0.0071	0.0002	-0.0079	-0.0019	-0.0080	-0.0219	-0.0078	0.0096	0.0151	-0.0073
		(1.8538)	(4.5100)	(1.4734)	(0.0255)	(1.4734)	(0.4911)	***(1.7627)***	(4.9530)	***(1.9988)***	(1.4193)	(1.9997)	***(1.7780)***
	Buy-Sell	0.0118	0.005	-0.0084	0.0322	0.0253	0.0029	0.0244	0.0244	0.0237	-0.0215	0.0013	0.0308
		(2.8336)	(1.3354)	(1.2356)	(3.5429)	(3.2329)	(0.4617)	***(3.5436)***	(3.7852)	***(4.1559)***	(2.2580)	(0.1314)	***(4.8197)***

N(Buy) and N(Sell) are the number of buy and sell signals generated during the sample period, respectively. Numbers in parentheses are standard t-statistics using a two-tailed test. The Bond and Italic numbers of t-test values in the parentheses indicate the statistical significance at 1%, 5%, or 10% levels.

Appendix 3: Empirical results of the trading range breakout rules (TRB) with bands of 0%, 0.5%, 1%, and 3%

Appendix 3 shows the mean 10-day inflation adjusted returns generated by the TRB rules with bands of 0%, 0.5%, 1%, and 3%. Similar to the VMA and FMA rules, the TRB rules without a band generate the highest number of signals; rules with bands of 0.5%, 1%, and 3% are ranked second, third and fourth, respectively. However, different from the VMA and FMA rules, for most stock markets, the TRB rules with a band of 0.5% generate similar number of signals with rules without a band. The mean 10-day returns generated by the TRB rules with a 0.5% band are similar to the returns generated by the TRB rules without a band. In addition, the TRB rules with a band of 1% can generate smaller number of signals than rules with bands of 0% and 0.5%, but can earn higher returns. For example, in the Korea and Malaysia stock markets, the mean 10-day returns of (1,50,0) rule are 0.89% and 1.42%, respectively; the mean 10-day returns of (1,50,0.005) rule are 0.88% and 1.42%, respectively; while the mean 10-day returns of (1,50,0.01) rules are 1.18% and 1.43%, respectively. It shows that the mean 10-day returns of the TRB rules with 0% and 0.5% bands are very similar and lower than the mean 10-day return generated by the TRB rules with a 1% band. The results show all the TRB rules with band of 3% can not detect any signals for the Australian stock market and only generate few signals for other stock markets. Therefore, consistent with previous studies (Brock et al., 1992; Bessembinder and Chan 1995, 1998), this study considers a one percent band is more appropriate to filter out false signals generated by the TRB rules.

Appendix 3: Empirical results of the trading range breakout rules (TRB) with bands of 0%, 0.5%, 1%, and 3%

TRB rules adjusted for inflation													
		Developed Stock Markets						Emerging Stock Markets					
		Australia	NZ	Japan	HK	Korea	Singapore	Malaysia	Indonesia	Thailand	Shanghai	Shenzhen	Philippines
Buy-and-hold returns		0.23%	0.10%	-0.24%	0.36%	0.26%	0.16%	0.21%	0.30%	0.07%	0.46%	0.47%	0.26%
Rules													
(1,50,0)	N(Buy)	156	116	108	138	130	129	126	134	107	101	102	104
	N(Sell)	69	81	108	77	97	80	79	81	92	91	99	85
	Buy	0.0018	0.0024	-0.0015	0.0057	0.004	0.0041	0.0099	0.015	***0.0126***	0.0158	0.009	0.0145
		(2.1153)	***(2.8338)***	(0.8956)	***(3.7151)***	***(2.3504)***	***(3.3928)***	***(7.4721)***	***(10.9392)***	***(7.6871)***	***(7.0583)***	***(3.9325)***	***(9.4716)***
	Sell	0.0009	-0.0021	0.002	-0.0053	-0.0049	-0.012	-0.0043	-0.0184	-0.0041	-0.0063	-0.0044	-0.0065
		(0.6265)	***(2.2638)***	(1.5001)	***(2.9067)***	***(2.5925)***	***(8.2200)***	***(2.6857)***	***(10.7737)***	***(2.2478)***	***(2.8473)***	***(2.0713)***	***(4.0298)***
	Buy-Sell	0.0009	0.0045	-0.0035	0.011	0.0089	0.0161	0.0142	0.0334	0.0167	0.0221	0.0134	0.021
		(0.6652)	***(3.5914)***	(1.7133)	***(4.6035)***	***(3.5396)***	***(8.6405)***	***(6.8235)***	***(15.3881)***	***(6.9502)***	***(7.0110)***	***(4.2900)***	***(9.4380)***
(1,50,0.005)	N(Buy)	99	81	80	116	115	95	96	115	89	84	87	92
	N(Sell)	60	59	94	69	90	73	72	71	82	78	85	75
	Buy	0.0003	0.0003	-0.0014	0.005	0.0043	0.0059	0.01	0.0165	0.0123	0.0134	0.016	0.0124
		(0.0706)	(0.1865)	(0.7246)	***(2.9559)***	***(2.3803)***	***(4.2906)***	***(6.6047)***	***(11.2221)***	***(6.8849)***	(5.4846)	***(6.5450)***	***(7.6241)***
	Sell	-0.0004	-0.0039	-0.0012	-0.0055	-0.0045	-0.0064	-0.0042	-0.0121	-0.004	-0.0036	-0.0046	-0.0059
		(0.4913)	(3.5119)	(0.6340)	***(2.8519)***	***(2.5246)***	***(4.2414)***	***(2.4964)***	***(6.7038)***	***(2.0951)***	(1.5367)	***(2.0032)***	***(3.4669)***
	Buy-Sell	0.0007	0.0042	-0.0002	0.0105	0.0088	0.0123	0.0142	0.0286	0.0163	0.017	0.0206	0.0183
		(0.4340)	(2.8101)	(0.1029)	***(4.1021)***	***(3.5104)***	***(6.0709)***	***(6.2693)***	***(12.3287)***	***(6.3373)***	(4.9641)	***(6.0923)***	***(7.7528)***

(1,50,0.01)	N(Buy)	36	40	49	85	87	69	68	92	69	66	67	77
	N(Sell)	41	33	83	57	77	64	59	61	76	70	78	67
	Buy	0.0005	-0.0023	0.0039	0.0049	0.0075	0.0038	0.0098	0.0179	0.0134	0.0127	0.0179	0.0133
		(0.1575)	(1.7418)	(1.9049)	***(2.4889)***	***(3.6686)***	(2.3288)	***(5.4464)***	***(10.8867)***	***(6.6060)***	(4.6169)	***(6.4690)***	***(7.4807)***
	Sell	0.0023	-0.0075	-0.0022	-0.0065	-0.0043	-0.0022	-0.0045	-0.0188	-0.0041	-0.0031	-0.0047	-0.0041
		(1.4573)	(5.0103)	(1.2002)	***(3.0410)***	***(2.0362)***	(1.3869)	***(2.4205)***	***(9.5738)***	***(2.0709)***	(1.2829)	***(1.9618)***	***(2.2782)***
	Buy-Sell	-0.0018	0.0052	0.0061	0.0114	0.0118	0.006	0.0143	0.0367	0.0175	0.0158	0.0226	0.0174
		(0.8854)	(2.5458)	(2.2560)	***(3.9581)***	***(4.0321)***	(2.6330)	***(5.5213)***	***(14.4131)***	***(6.2576)***	(4.2420)	***(6.1321)***	***(6.8221)***
(1,50,0.03)	N(Buy)	0	2	9	11	15	9	7	17	17	18	23	23
	N(Sell)	6	4	29	25	31	17	22	31	36	23	22	21
	Buy	0	-0.0143	0.0145	0.0054	0.0208	-0.0085	0.016	0.021	0.0177	0.019	0.0446	0.0219
		(NA)	(2.3575)	(2.9476)	(1.0032)	***(4.2667)***	(1.9719)	***(2.8921)***	***(5.5516)***	***(4.3534)***	(3.6426)	***(9.5609)***	***(6.8252)***
	Sell	0.0017	-0.0077	-0.003	-0.0073	-0.0055	-0.0035	-0.0051	-0.0199	-0.0079	-0.0043	-0.0118	-0.0087
		(0.4056)	(1.7971)	(1.0006)	(2.2577)	***(3.7282)***	(1.1419)	***(1.6771)***	***(7.2427)***	***(2.7819)***	(0.9938)	***(2.5464)***	***(2.6769)***
	Buy-Sell	-0.0017	-0.0066	0.0175	0.0127	0.0263	-0.005	0.0211	0.0409	0.0256	0.0233	0.0564	0.0306
		(NA)	(0.8873)	(3.0659)	(2.0883)	***(5.1923)***	(0.9230)	***(3.3468)***	***(8.7940)***	***(5.1760)***	(3.3949)	***(8.5304)***	***(6.6664)***
(1,150,0)	N(Buy)	119	79	61	102	82	91	86	91	58	69	65	66
	N(Sell)	34	34	59	31	55	31	37	40	47	41	47	42
	Buy	0.0011	0.0015	-0.003	0.0052	0.0017	0.0048	0.009	0.0118	0.0126	0.0108	0.01	0.0056
		(1.0096)	(1.4458)	(1.4259)	(2.8960)	(0.7517)	***(3.3832)***	***(5.6506)***	***(7.0902)***	***(5.7029)***	***(4.0184)***	(3.4337)	***(2.8863)***
	Sell	0.0023	-0.007	0.0072	0.0002	-0.0028	-0.0166	-0.0039	-0.0235	-0.0045	-0.0048	-0.0037	-0.0062
		(1.3735)	(4.8092)	(3.7738)	(0.0521)	(1.1353)	***(7.0792)***	***(1.6711)***	***(9.7062)***	***(1.7950)***	***(4.0184)***	(1.2214)	***(2.7049)***

	Buy-Sell	-0.0012	0.0085	-0.0102	0.005	0.0045	0.0214	0.0129	0.0353	0.0171	0.0156	0.0135	0.0118
		(0.7338)	(4.8354)	(3.7137)	(1.4590)	(1.3638)	***(7.8559)***	***(4.5302)***	***(12.0798)***	***(5.1797)***	***(3.6465)***	(3.1789)	***(3.9365)***
(1,150,0.005)	N(Buy)	71	51	43	85	75	67	66	76	49	58	57	59
	N(Sell)	28	30	55	28	51	28	34	34	47	36	42	39
	Buy	0.0001	-0.0001	-0.0007	0.007	0.002	0.0065	0.0102	0.0131	0.0109	0.0111	0.0127	0.0021
		(0.1667)	(0.1239)	(0.2073)	(3.6239)	(0.8759)	(3.9331)	***(5.6141)***	***(7.2166)***	***(4.5439)***	(2.7671)	(4.1910)	(0.9536)
	Sell	0.0026	-0.0078	0.0071	-0.0001	-0.003	-0.0032	-0.004	-0.0155	-0.0044	-0.0021	-0.0037	-0.003
		(1.4073)	(4.9797)	(3.6103)	(0.1324)	(1.2672)	(1.3427)	***(1.6424)***	***(5.9238)***	***(1.7544)***	(0.6387)	(1.1541)	(1.3108)
	Buy-Sell	-0.0025	0.0077	-0.0078	0.0071	0.005	0.0097	0.0142	0.0286	0.0153	0.0132	0.0164	0.0051
		(1.2846)	(3.8882)	(2.5614)	(1.9352)	(1.5391)	(3.2814)	***(4.6356)***	***(8.9862)***	***(4.4556)***	(2.8526)	(3.6301)	(1.6266)
(1,150,0.01)	N(Buy)	23	21	28	59	54	45	44	57	39	45	42	47
	N(Sell)	23	20	48	22	41	26	33	30	43	33	40	35
	Buy	-0.0017	-0.0067	0.0056	0.0072	0.0073	0.0046	0.0056	0.015	0.0137	0.0132	0.0187	0.0033
		(1.0018)	(3.5817)	(2.0597)	(3.1163)	(2.7950)	(2.2788)	***(2.5122)***	***(7.1766)***	***(5.1060)***	(3.9600)	(5.3599)	(1.4038)
	Sell	0.0002	-0.0083	-0.0008	-0.0001	-0.0032	-0.0032	-0.0041	-0.0155	-0.0047	-0.0021	-0.0039	-0.0038
		(0.0174)	(4.3554)	(0.2709)	(0.1175)	(1.1176)	(1.2955)	***(1.6576)***	***(5.5902)***	***(1.7953)***	(0.7479)	(1.846)	(1.5527)
	Buy-Sell	-0.0019	0.0016	0.0064	0.0073	0.0105	0.0078	0.0097	0.0305	0.0184	0.0153	0.0226	0.0071
		(0.6978)	(0.6166)	(1.8070)	(1.7370)	(2.6929)	(2.4198)	***(2.9097)***	***(8.7790)***	***(4.9566)***	(3.4184)	(4.6157)	(2.1016)
(1,150,0.03)	N(Buy)	0	1	3	8	11	4	5	9	10	11	16	15
	N(Sell)	4	3	18	12	17	11	14	15	20	13	14	13
	Buy	0	-0.002	0.0163	0.0073	0.0087	0.011	0.0211	0.0312	0.0149	0.0151	0.046	0.0141
		(NA)	(0.2464)	(1.9113)	(1.1707)	(1.5125)	(1.6631)	***(3.2293)***	***(6.0172)***	(2.8151)	***(2.2578)***	***(8.2406)***	***(3.5469)***

	Sell	-0.0005	-0.0174	-0.0011	-0.0011	-0.004	-0.0053	-0.0071	-0.0213	-0.0055	-0.0101	-0.0139	-0.007
		(0.1595)	(3.5167)	(0.2514)	(0.2923)	(2.0481)	(1.3753)	***(1.8533)***	***(5.3979)***	(1.4398)	***(1.7054)***	***(2.3872)***	***(1.7069)***
	Buy-Sell	0.0005	0.0154	0.0174	0.0084	0.0127	0.0163	0.0282	0.0525	0.0204	0.0252	0.0599	0.0211
		(NA)	(1.5455)	(1.8652)	(1.0927)	(2.1118)	(2.1358)	***(3.7256)***	***(8.0724)***	(3.1340)	***(2.8205)***	***(7.3875)***	***(3.6717)***
(1,200,0)	N(Buy)	111	72	53	97	70	83	75	85	48	62	61	58
	N(Sell)	27	29	55	25	48	28	31	28	38	32	36	36
	Buy	0.0013	0.0011	-0.0025	0.0061	0.0032	0.0045	0.0088	0.0121	0.0129	0.0134	0.0136	0.0079
		(1.2633)	(1.0158)	(1.0999)	(3.3280)	(1.3844)	***(3.0062)***	(5.1409)	***(7.0554)***	***(5.3252)***	(4.7402)	(4.6547)	***(3.8237)***
	Sell	0.0026	-0.005	0.0111	-0.0034	-0.0033	-0.0203	-0.0012	-0.0274	-0.0098	0.0028	0.0016	-0.0075
		(1.3667)	(3.2005)	(5.5726)	(1.0942)	(1.2451)	***(8.2332)***	(0.4992)	***(9.4431)***	***(3.5414)***	(0.6518)	(0.3575)	***(3.0129)***
	Buy-Sell	-0.0013	0.0061	-0.0136	0.0095	0.0065	0.0248	0.01	0.0375	0.0227	0.0106	0.012	0.0154
		(0.6639)	(3.2590)	(4.7158)	(2.5002)	(1.8534)	***(8.6638)***	(3.2236)	***(11.7581)***	***(6.2142)***	(2.2561)	(2.5730)	***(4.7566)***
(1,200,0.005)	N(Buy)	67	48	37	80	64	62	58	74	41	51	54	53
	N(Sell)	22	26	52	23	44	26	29	25	37	27	34	34
	Buy	0.0012	-0.0011	-0.0027	0.0065	0.0024	0.0062	0.0091	0.0134	0.0133	0.0138	0.013	0.005
		(0.9220)	(0.9324)	(0.9981)	(3.2542)	(0.9762)	(3.6381)	(4.6853)	***(7.3220)***	***(5.0746)***	(4.4126)	(4.1912)	(2.2862)
	Sell	-0.0004	-0.0079	0.0107	-0.0034	-0.003	-0.0033	-0.0022	-0.0211	-0.0097	0.0031	0.0063	-0.0013
		(0.3277)	(4.7022)	(5.2314)	(1.0578)	(1.1919)	(1.3330)	(0.8525)	***(6.8893)***	***(3.4689)***	(0.6809)	(1.5750)	(0.5899)
	Buy-Sell	0.0016	0.0068	-0.0134	0.0099	0.0054	0.0095	0.0113	0.0345	0.023	0.0107	0.0067	0.0063
		(0.7466)	(3.2420)	(4.1576)	(2.4853)	(1.5479)	(3.1125)	(3.4199)	***(9.6804)***	***(6.0352)***	(2.0606)	(1.3840)	(1.8993)
(1,200,0.01)	N(Buy)	21	19	26	57	47	43	40	55	31	40	40	42
	N(Sell)	17	17	46	18	34	24	28	21	35	26	33	29

	Buy	-0.0012	-0.0097	0.0047	0.0077	0.0059	0.0044	0.0095	0.0169	0.0193	0.0155	0.0187	0.0052
		(0.7253)	(4.9601)	(1.6829)	(3.2748)	(2.1234)	(2.1329)	(4.0717)	***(7.9637)***	***(6.3958)***	(4.4253)	(5.2265)	(2.1246)
	Sell	-0.0029	-0.0084	0.0035	-0.0035	-0.0041	-0.0034	-0.003	-0.0259	-0.0099	0.0093	0.0007	-0.0004
		(1.4222)	(4.0553)	(1.6748)	(0.9614)	(1.2973)	(1.3127)	(1.1283)	***(7.7477)***	***(3.4447)***	(2.1045)	(0.1102)	(0.2128)
	Buy-Sell	0.0017	-0.0013	0.0012	0.0112	0.01	0.0078	0.0125	0.0428	0.0292	0.0062	0.018	0.0056
		(0.5730)	(0.4639)	(0.3375)	(2.4538)	(2.3743)	(2.3367)	(3.4918)	***(10.8163)***	***(7.0425)***	(1.1479)	(3.4502)	(1.5280)
(1,200,0.03)	N(Buy)	0	1	2	8	8	4	5	8	9	8	14	12
	N(Sell)	4	2	16	11	16	11	13	14	19	13	10	13
	Buy	0	-0.002	0.0153	0.008	0.0181	0.0125	0.0231	0.0462	0.0269	0.0205	0.0609	0.013
		(NA)	(0.2464)	(1.4662)	(1.2887)	***(2.7118)***	(1.8925)	(3.5370)	***(8.4410)***	***(4.8109)***	(2.6258)	(10.2216)	(2.9143)
	Sell	0.0053	-0.012	0.0016	-0.0036	-0.005	-0.0056	-0.0042	-0.03	-0.0185	0.0021	-0.0012	-0.0042
		(1.2303)	(1.9803)	(0.4837)	(0.7718)	***(2.4206)***	(1.4514)	(1.0674)	***(7.3246)***	***(4.7683)***	(0.3082)	(0.2093)	(1.0433)
	Buy-Sell	0.0053	0.01	0.0137	0.0116	0.0231	0.0181	0.0273	0.0762	0.0454	0.0184	0.0621	0.0172
		(NA)	(0.9424)	(1.2211)	(1.4828)	***(3.3212)***	(2.3717)	(3.5708)	***(11.1628)***	***(6.6756)***	(1.8776)	(6.7699)	(2.8280)

N(Buy) and N(Sell) are the number of buy and sell signals generated during the sample period, respectively. Numbers in parentheses are standard t-statistics using a two-tailed test. The Bond and Italic numbers of t-test values in the parentheses indicate the statistical significance at 1%, 5%, or 10% levels.

Appendix 4: Calculation of the estimated breakeven costs

Appendix 4 describes the calculation of the estimated breakeven cost for the VMA (1,50,0) rule for Australia stock market. The breakeven costs are the percentage round-trip costs needed to offset the additional returns earned by the technical trading rules relative to a buy-and-hold strategy. First, we compute the additional returns (π). The following formula is used to calculate the additional returns (π):

$$\begin{aligned}\pi &= \sum_{i=1}^{N_b}(BR_i - R_i) + \sum_{j=1}^{N_s}(SR_j - R_j) \\ &= \sum_{i=1}^{N_b}(2R_i - R_i) + \sum_{j=1}^{N_s}(o - R_j) \\ &= \sum_{i=1}^{N_b}(R_i) - \sum_{j=1}^{N_s}(R_j)\end{aligned}$$

Where BR_i is the trading returns on days the buy position is held

SR_j is the trading returns on days the sell position is held

N_b is the number of days the buy position is held

N_s is the number of days the sell position is held

R_i is the index return on day i

R_j is the index return on day j

For example, for the VMA (1,50,0) rule for Australia stock market, the additional returns (π)=2913*0.0004-1733*(-0.0001)=1.3385

		Australia
Buy-and-hold returns		0.0215%
Rules		
(1,50,0)	N(Buy)	2913
	N(Sell)	1733
	Buy	0.0004
		(0.7328)
	Sell	-0.0001
		(1.2619)
	Buy-Sell	0.0005
		(1.7388)

Second, the estimated breakeven costs are calculated using the following formula:

$$C = \frac{\pi}{n_b + n_s}$$

Where n_b and n_s is the number of buy and sell signals generated, respectively.

Similarly, the round-trip breakeven costs C=1.3385/(2913+1733)=0.03% for the VMA (1,50,0) rule for the Australian stock market.